OREGON COOLING NEEDS STUDY

Submitted to the
OREGON LEGISLATURE

by the
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Prepared by
Parametrix | good company

Acknowledgements

Project Team

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- Andy Cameron, Energy Efficiency & Conservation Manager, Oregon Department of Energy

Consulting Team

Good Company (a division of Parametrix), a sustainability management consulting firm based in Eugene, Oregon, completed this Oregon Cooling Needs Study in partnership with Verde. Grace Kaplowitz served as project manager, research analyst, and coauthor of this report. Suzy Godber and Tracy Lunsford served as project researchers, analysts, and coauthors. Aaron Toneys served as technical analyst. Josh Proudfoot provided project guidance, analysis, and quality control. Parametrix served as the geographic information systems mapping team on the project. Chad Tinsley was the primary GIS analyst and created the Heat Vulnerability Index tool and PowerBI Dashboard. Cortney Messer conducted the survey data analysis, and Josh Ahmann provided GIS oversight and quality control.

Verde, an environmental justice nonprofit in Portland, Oregon, was a key partner in the Oregon Cooling Needs Study. The Verde team provided significant support in developing the outreach strategy, connecting with key community partners, developing the survey, and providing Spanish transcreation for all outreach materials. Additionally, they distributed the survey via email and social media in the Portland Metro area. Ricardo Moreno, Ron White, Cheyenne Holliday, Anahi Segovia Rodriguez, and Sentilla Hawley were the primary Verde staff members on the project.

Community-Based Organization Outreach Partners

The following CBO partners conducted outreach to Oregon's most vulnerable communities, provided qualitative input on their experiences providing services, and informed the outreach approach. Without them, this project would not be possible.

- Community in Action
- Homes for Good
- Lake County Resources Initiative
- McKenzie Valley Long-Term Recovery Group
- Oregon Rural Action
- Pineros y Campesinos Unidos del Noroeste
- Unete

Utility Outreach Partners

- Eugene Water and Electric Board
- Portland General Electric
- Umatilla Electric Cooperative

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- Casa of Oregon
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- Housing Oregon
- Lake Klamath Community Action Services
- Mid-Willamette Valley Community Action Agency
- NeighborImpact
- Oregon Energy Fund
- Rogue Climate
- Santiam Canyon Long-Term Recovery Group
- St. Vincent de Paul
- United Community Action Network

Table of Contents

Executive Summary

The purpose of this study is to understand the cooling needs of Oregon households living in the housing types most vulnerable to heat. This is part of a larger effort toward meeting the cooling needs of every Oregonian and protecting the health and safety of individuals in the face of increasing heat events due to climate change. The housing types included in the study are manufactured dwelling parks/mobile homes, publicly supported housing (multifamily), recreational vehicles, and employer-provided agricultural workforce housing (ag housing).

Key Findings

The study found that:

- Many Oregonians do not have adequate cooling equipment, including 58 percent of residents living in the housing types surveyed.
- The estimated total cost to provide the health and safety baseline level of cooling equipment to avoid the worst effects of extreme heat events is **$604,400,000.**
- The estimated total cost to provide comprehensive cooling (permanently installed equipment to properly cool the full living space in each housing unit) is **$1,082,700,000.**
- The average county heat vulnerability index is 57. The counties with the highest heat vulnerability are Morrow (68), Multnomah (68), Malheur (67), Marion (64), Umatilla (62), and Wheeler (61).
- The study also identified social and economic barriers residents face in accessing existing resources and found that only 22 percent of surveyed individuals have used existing cooling, weatherization, or utility bill assistance programs.

Figures ES-1 and Table ES-1 illustrate the immediate and long-term cooling needs as projected by housing type and region (Figure ES-1 does not include ag housing).

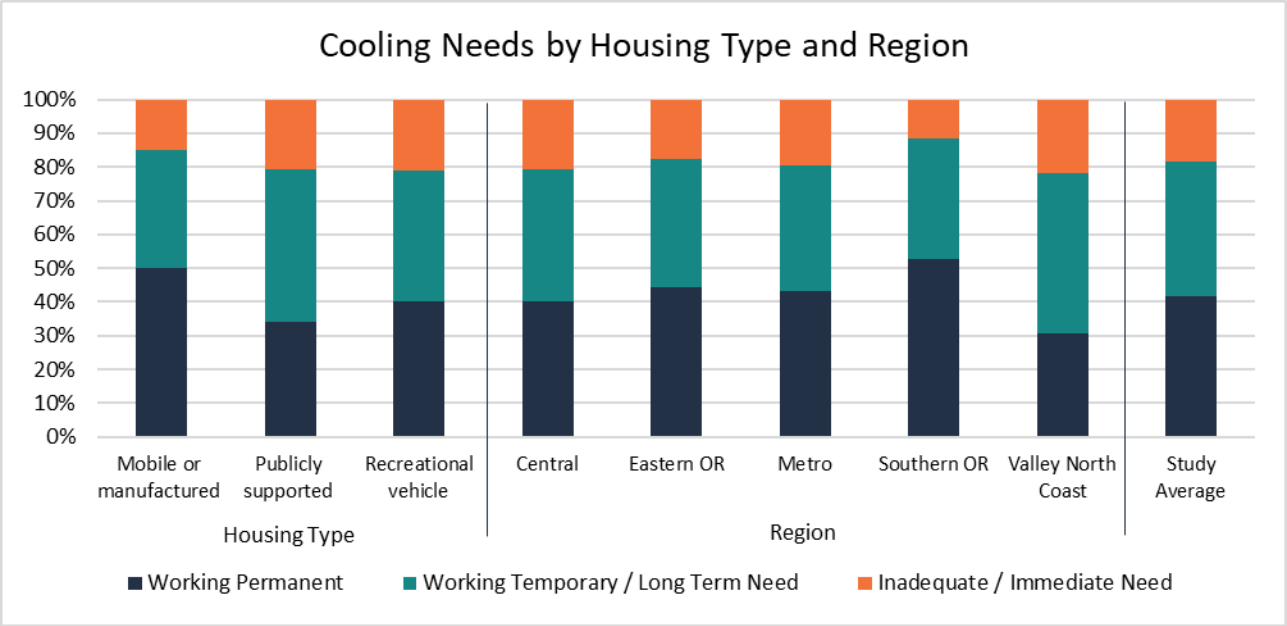

Figure ES-1: Cooling Needs by Housing Type and Region

Table ES-1: Housing Units and Survey Responses Included in the Study by Housing Type

	Manufactured	Multifamily	RV	Ag Housing
Number of survey responses (percentage)	406 (43%)	410 (43%)	132 (14%)	Not included
Number of units statewide	78,900	17,600	6,300	2,100
% Immediate need **Projected Statewide Units**	15% **12,900**	21% **3,700**	21% **1,300**	Unknown
% Long-term need **Projected Statewide Units**	35% **27,600**	45% **8,000**	39% **2,400**	100% **2,100**

Investment Needed to Meet Statewide Cooling Needs: $604,400,000 to $1,082,700,000.

- **Health and Safety Baseline**: Estimation of a baseline level of cooling equipment to avoid the worst effects of increased extreme heat events: **$604,400,000**.
    - Manufactured, multifamily, and ag housing: Ductless heat pumps – one zone per housing unit
    - RV: Temporary air conditioning – one per housing unit
- **Comprehensive Cooling**: Installation of permanent cooling equipment to properly cool the full living space in each housing unit: **$1,082,700,000**.
    - Manufactured, multifamily, and ag housing: Ductless heat pumps – one zone per bedroom plus one zone for common spaces
    - RV: Permanent air conditioning – one per housing unit

Additional Actions that Complement Unit-by-Unit Cooling Equipment

- Passive cooling such as cool roofs, deciduous shade, and shade structures.
- Expanding water access via portable pools, hydration stations, misters and splash pads.
- Community cooling facilities and emergency cooling shelters.

Heat Vulnerability Index and Understanding Heat Vulnerability

The Heat Vulnerability Index is an interactive, online geographic information system tool. It was created alongside this study to inform policy decisions and lay the foundation for further analysis. The Heat Vulnerability Index overlays the interaction of physical sensitivity to heat and illness, level of exposure to extreme heat, and ability to adapt and recover from exposure events.

Addressing Programmatic Barriers to Better Serve Diverse Populations

Survey responses indicate that only 22 percent of respondents[i] have used existing cooling and utility bill assistance programs. The remaining 78 percent have not used them, either because they were unaware or because of cited programmatic barriers.

[i] Living in manufactured/mobile homes, publicly supported housing (multifamily), and residential RVs.

Purpose, Context, and Approach of the Study

Purpose: This study is a result of the Oregon legislature (Senate Bill 1536) and health and safety advocates' response to the record-breaking heat wave during the summer of 2021 and subsequent heat-related deaths, which highlighted the issue of cooling access statewide. The purpose of this study is to understand the cooling needs of Oregon households that live in the housing types most vulnerable to heat. This is part of a larger effort toward meeting the cooling needs of every Oregonian and protecting the health and safety of individuals in the face of increasing heat events due to climate change. Senate Bill 1536 directed the Oregon Department of Energy to complete this study.

Oregon Department of Energy: ODOE is a statewide agency created in 1975 working on behalf of Oregonians across the state. The agency's mission: *"[ODOE] helps Oregonians make informed decisions and maintain a resilient and affordable energy system. We advance solutions to shape an equitable clean energy transition, protect the environment and public health, and responsibly balance energy needs and impacts for current and future generations."*

Context – 2021 Heat Dome Catalyst Event: The June 2021 heat dome posed substantial risk to human health, with record setting temperatures of 116°F.[1] The heat dome resulted in more than 100 estimated deaths statewide, with 69 confirmed deaths in Multnomah County alone. Many of these heat-related deaths occurred in people's homes. In addition, there was also a large spike in heat-related emergency room visits and all-cause mortality associated with this event. The heat dome was not an isolated phenomenon. Temperatures are increasing across the U.S. and globally due to climate change, and heatwaves will continue to be a more frequent occurrence posing continued risks to human health.

Context – Increasing Heat Due to Climate Change: The prevailing historical trend and projection for the foreseeable future is an increase in the average temperatures across Oregon. Heat waves lasting more than a day or two have been significant public health crises. Oregon's historical mean for summer days with a heat index over 90°F is 13 days per year. By mid-century, the statewide average number of days over 90°F are projected to range from 25 to 48 days per year, depending on how fast the world reduces carbon emissions. The statewide average summer maximum temperatures, currently 79.1°F, are predicted to increase by between 5.6° and 7.5°F. These changes will affect regions across the state differently, as shown in the figures below. The area around Medford in southern Oregon and the area around Boardman in northeastern Oregon are expected to be particularly hard hit. Within any given climatic region, the need for cooling due to increased temperatures will vary based on other factors. For example, neighborhoods with ample tree cover and relatively little concrete and asphalt will cool off faster at night than neighborhoods with less greenery and more hard surfaces. Figure 1 below illustrates this effect. On a 95˚F day, a blacktop may reach up to 140˚F but grass in the shade made reach only 91˚F.

Time	Grass in shade	Grass in sun	Air Temp	Cement	Red Brick	Blacktop
7am	70	74	76	78	78	80
8	72	77	77	80	81	81
9	78	85	88	93	95	89
10	82	86	90	99	105	103
11	85	98	92	105	115	121
12pm	88	100	93	112	125	130
1	90	103	94	115	130	135
2	91	105	95	125	135	140
3	91	105	95	124	134	140
4	89	102	95	118	131	137
5	87	98	93	112	122	131
6	85	96	91	106	110	122
7	83	86	90	100	105	112
8	80	80 (dusk)	87	95	98	103
9	78	78 (dark)	84	90	92	93

Figure 1: Temperatures Across Surface Types, University of Georgia Extension[2]

The Oregon Cooling Needs Study was designed in consideration of these climactic differences, and targeted outreach efforts were made in areas with the highest concentration of the identified housing types and the most exposure to high temperatures. Figures 2 and 3[3] illustrate the projected change in days over 90°F in lower- and higher-emissions modeling scenarios.

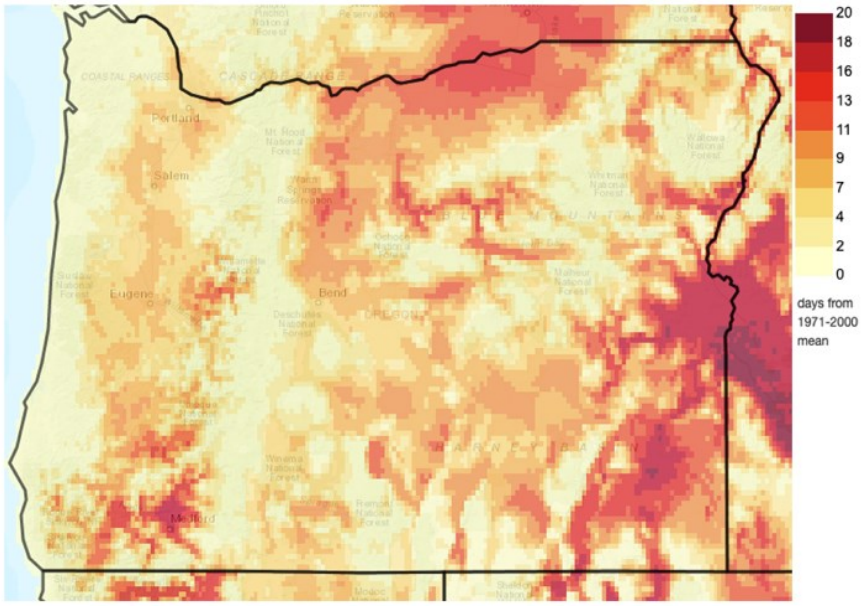

Figure 2: Projected Change in Days with Heat Index ≥90°F – Lower Emissions (RCP 4.5) 2010–2039 vs. Historical Simulation 1971–2000, Mean Change

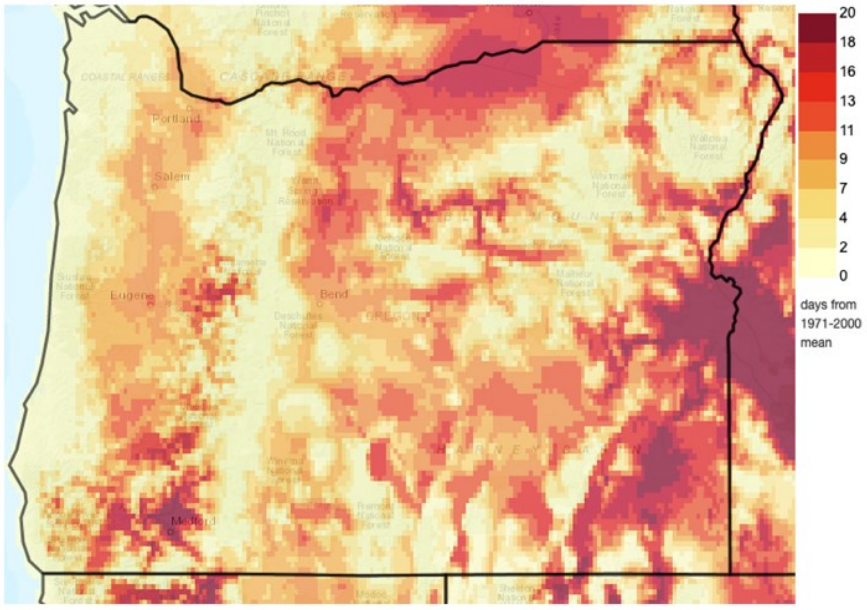

Figure 3: Projected Change in Days with Heat Index ≥90°F – Higher Emissions (RCP 8.5) 2010–2039 vs. Historical Simulation 1971–2000, Mean Change

Health Implications: According to the U.S. Environmental Protection Agency, "When people are exposed to extreme heat, they can suffer from potentially deadly illnesses, such as heat exhaustion and heat stroke. Hot temperatures can also contribute to deaths from heart attacks, strokes, and other forms of cardiovascular disease. Heat is the leading weather-related killer in the United States, even though most heat-related deaths are preventable through outreach and intervention."[4]

Study Approach: Through SB 1536, the Oregon legislature recognized the need to better understand which populations in Oregon will be most affected by heat into the future. The goals of this study and brief methodology are as follows:

1. The study is specifically focused on understanding housing and cooling equipment characteristics (housing prevalence and level of cooling available to homes by housing type) for four residential housing types: publicly supported housing (as defined in Oregon Revised Statute 456.20), manufactured dwelling parks/mobile homes, RVs being used as housing, and employer-provided agricultural workforce housing.
2. The study aims to understand the challenges that the Oregon communities most vulnerable to the risk of extreme heat experience in trying to stay safe, cool, and comfortable in their homes (such as equipment availability, cost of energy bills, broken equipment, and mobility limitations) and to measure awareness and usage of current cooling and related assistance programs.
3. Outreach and data collection were designed to foster trust and inform residents about cooling resources through the survey process in collaboration with a network of community-based organizations (CBOs).
4. All study research and data analysis results have been synthesized in this report and accompanying geographic information system tools to illustrate the data and findings in the study alongside an Oregon Heat Vulnerability Index. This study informs where cooling investments are needed statewide at household, neighborhood, and community levels.
5. The report includes place-based case studies to further illustrate the lived experiences of Oregon residents and highlight relevant programs and studies that may not be otherwise captured in the research. Findings from these case studies are presented throughout the report with detailed case studies in Appendix 2.
6. Agricultural workforce housing was added as an expansion to the report after the cooling needs survey was completed for the other housing types. Due to this and the unique nature of the housing type, it was researched independently from the other housing types in this study and the findings are highlighted in the agricultural workforce housing section of the report.
7. This study uses a regional approach to analyze survey findings based on five Oregon Regional solutions regions: Valley North Coast, Southern Oregon, Metro, Central Oregon, and Eastern Oregon.

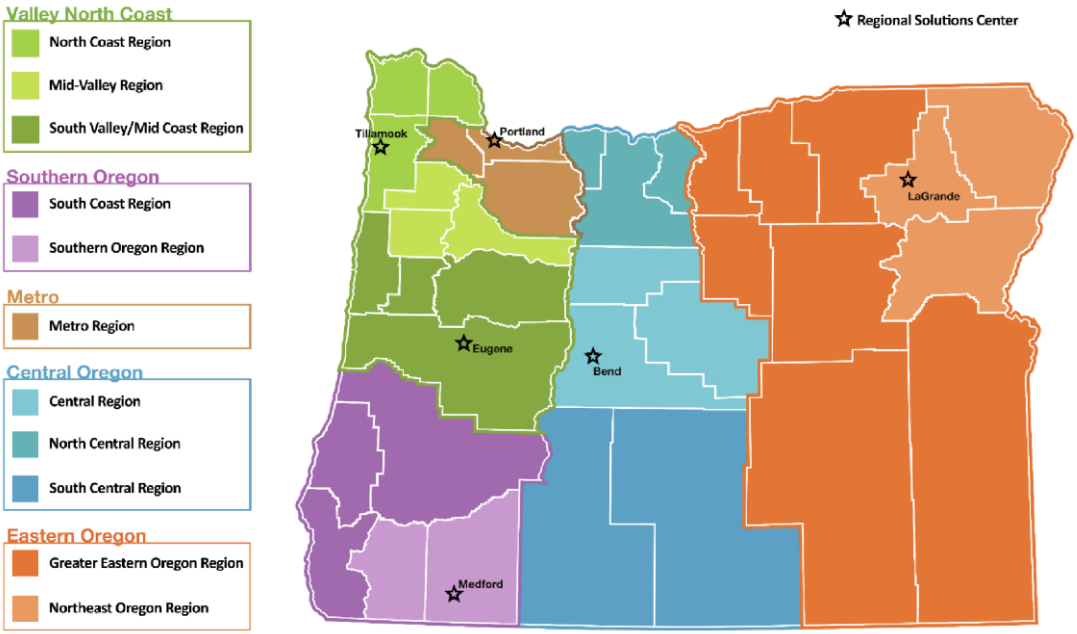

Figure 4: Oregon Regional Solutions Regional Map

Part I – Detailed Findings on Cooling Needs by Residential Housing Type

This section summarizes the housing types included in the study and the findings regarding the associated prevalence of cooling equipment and needs. These findings are based on the results of the cooling needs survey; the survey did not include agricultural workforce housing as it was researched independently.

Definitions of cooling types and quality of cooling for the purpose of this study:

- **Permanently installed equipment (permanent equipment)**: Central air conditioners, central heat pumps, ductless heat pumps
- **Temporarily installed equipment (temporary equipment)**: Window or wall air conditioners, portable air conditioners
- **Inadequate equipment**: Swamp coolers, sunshades/sunscreens/blinds, electric fans, no cooling equipment

Definitions of cooling needs for the purpose of this study:

- **Immediate need**: Households that do not have cooling equipment or only have inadequate equipment have an immediate need for permanent (or temporary) cooling equipment
- **Long-term need**: Households that only have temporary cooling equipment have a long-term need for permanent equipment

Immediate and long-term cooling needs are projected by housing type and region in Table 1 and Figures 5 and 6.

Table 1: Housing Units and Survey Responses Included in the Study by Housing Type

	Manufactured	Multifamily	RV	Ag Housing
Number of survey responses (percentage)	406 (43%)	410 (43%)	132 (14%)	Not included
Number of units statewide	78,900	17,600	6,300	2,100
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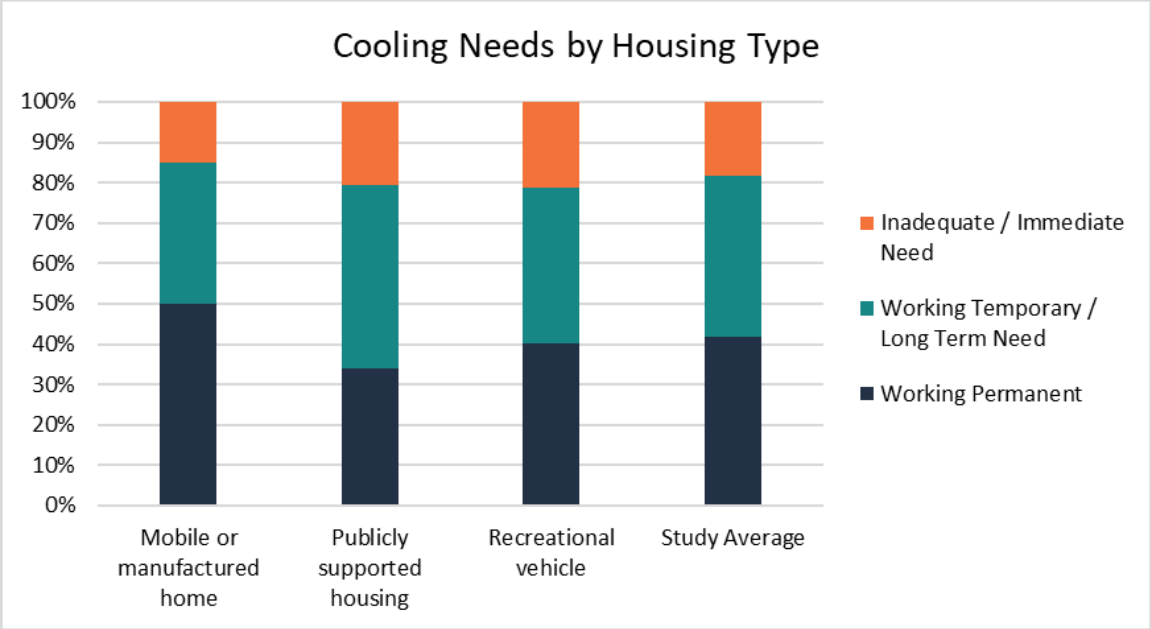


Figure 5: Cooling Needs by Housing Type

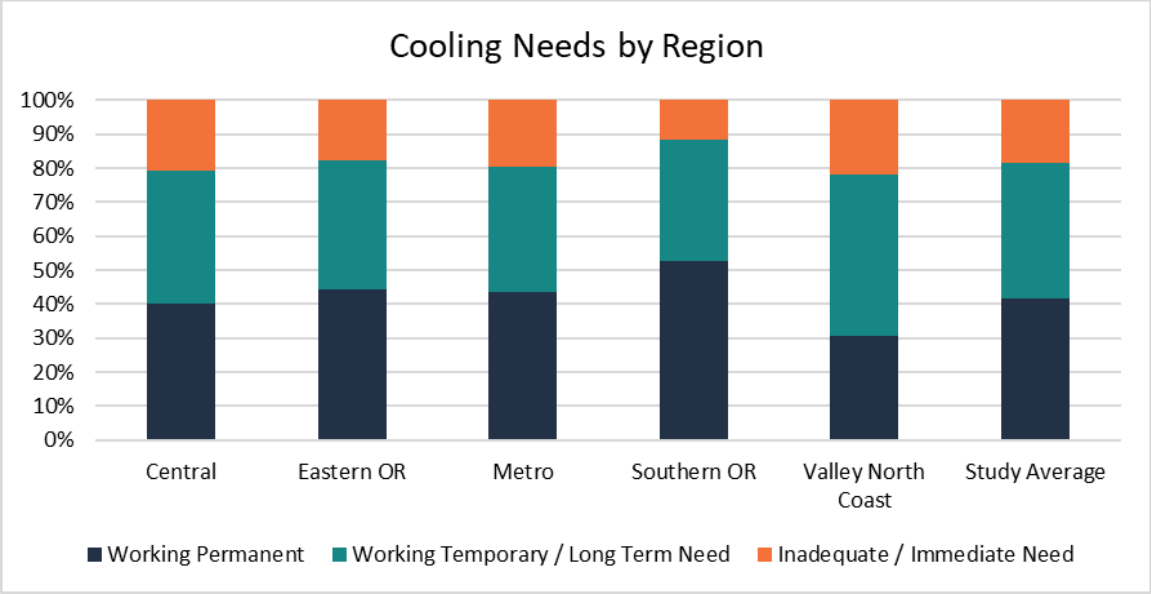


Figure 6: Cooling Needs by Region

Manufactured Dwelling Parks/Mobile Homes

Manufactured and mobile homes are prefabricated housing units that are primarily assembled in factories off-site from where they are ultimately placed. The distinction between manufactured and mobile homes, according to the U.S. Department of Housing and Urban Development, is the date they were built. Factory-built homes built before 1976 are defined as mobile homes, and those built after 1976 are defined as manufactured homes. Manufactured and mobile homes are classified based on size and style as single wide, double wide, triple wide, or modular/prefabricated.[ii]

Cooling Needs in Manufactured/Mobile Homes

Table 2 below displays the prevalence of functional cooling equipment by type in manufactured/mobile homes. Note that this was a multiple choice, "select all that apply" question, and many respondents indicated that they had multiple types of cooling equipment.

[ii] Since manufactured/mobile homes are manufactured off-site, they are transported on trailers. A single-wide home is generally fully constructed off-site and transported on a single trailer to its destination. Double- and triple-wide homes are delivered in two or three sections, respectively, and assembled on-site.

Table 2: Prevalence of Functional Cooling Equipment by Type – Manufactured/Mobile Homes

Responses	Permanent			Temporary			Inadequate		
	Central AC	Central Heat Pump	Ductless Heat Pump	Window or wall AC	Portable AC	Swamp cooler*	Electric fans**	Shades or blinds	No cooling
#	136	79	40	130	73	22	150	86	30
%	33%	19%	10%	32%	18%	5%	37%	21%	7%

**Evaporation or swamp cooler*
***Ceiling or portable fans*

Table 3 shows survey findings on the percentages of residents in manufactured and mobile homes with immediate, long-term, or no new equipment needs, categorized by their current cooling equipment.

Table 3: Cooling Needs for Manufactured/Mobile Homes

Manufactured/Mobile Home Cooling Need	Survey Responses	Projected % of total housing units	Projected # of total housing units
Immediate Need (Inadequate cooling only)	**61**	**15%**	**11,800**
Long-Term Need (Functional temporary cooling)	142	35%	27,600
No New Equipment Needs (Functional permanent cooling)	203	50%	39,500

Figure 7 illustrates the quality of cooling that works by region for manufactured and mobile homes based on survey responses.

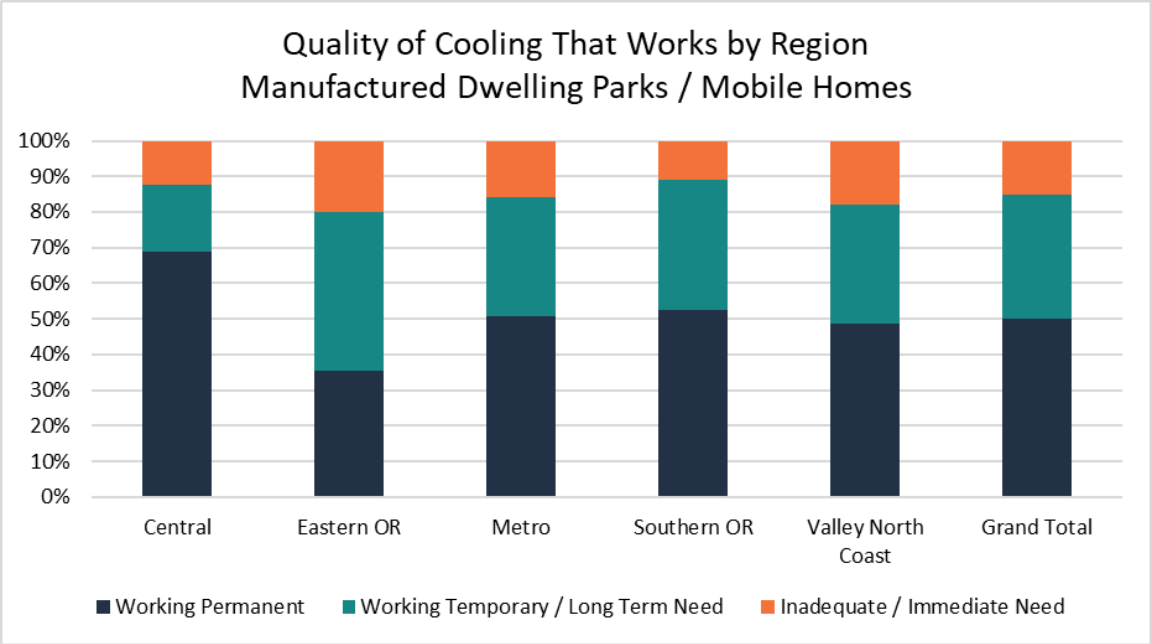


Figure 7: Quality of Cooling That Works by Region – Manufactured/Mobile Homes

Challenges for Meeting Cooling Needs in Manufactured/Mobile Homes

Over the course of the study, partner CBOs identified the following unique considerations for this housing type:

Structural challenges in older, low-efficiency models

- Poor insulation and leaky building envelopes make it more expensive to cool (and heat) these homes.
- Potential for mold and mildew pose additional health and safety concerns for residents living in these homes, particularly those with inadequate heating, ventilation, and air conditioning systems.
- Asbestos, lead, and formaldehyde materials in older models may pose challenges to upgrades.
- Unsafe electrical and wiring and inadequate amperage capacity can create barriers for adding new cooling equipment.
- The cost of cooling equipment and related weatherization and building envelope upgrades needed to make a home safe, comfortable, and efficient outweighs the value of some older mobile homes.

Specific conditions for urban and rural locations

- Residents living in manufactured/mobile homes in rural communities experience higher instances of compounding vulnerabilities (low income, health disparities, educational attainment[iii].
- Rural community members face increased risks of wildfire during the hot months and have less access to water spray play areas and pools. Many popular swimming holes in rivers and lakes may pose other hazards and rarely have lifeguards, accessible access, or managed swimming areas.
- The housing stock in many rural communities is particularly challenged in terms of age and state of repair, and rural communities have fewer readily available contractors, programs, and resources to maintain units.

Equity and Cultural Considerations

Manufactured/mobile homes make up the largest percentage of units included in this study, and the energy burden for these households is often disproportionately high (as shown in Figure 8). Mobile homes have a very high per-unit and per-square-foot energy intensity. This often leads to residents being stuck in a cycle of high bills and being unable to afford additional equipment or upgrades that would ultimately lower their ongoing costs. While upgrades are certainly needed and a good solution for newer units, in many cases it would be best for resident's health and safety and energy efficiency to replace older mobile and manufactured homes entirely. This is especially pertinent in cases where the cost of cooling equipment and heating, ventilation, and air conditioning upgrades needed to make a home safe, comfortable, and efficient outweigh the value of the home, and/or when upgrades are unable to overcome the shortcomings of the building envelopes.

Good Company findings from the City of Eugene Decarbonization project illustrate the high energy use and burden of residents living in manufactured/mobile homes. Figure 8 illustrates the findings in units of greenhouse gas emissions measured in metric tons of carbon dioxide equivalent. Greenhouse gas emissions can be used as a proxy for energy use and, therefore, energy cost and energy burden.

[iii] Based on findings from the Heat Vulnerability Index portion of this study.

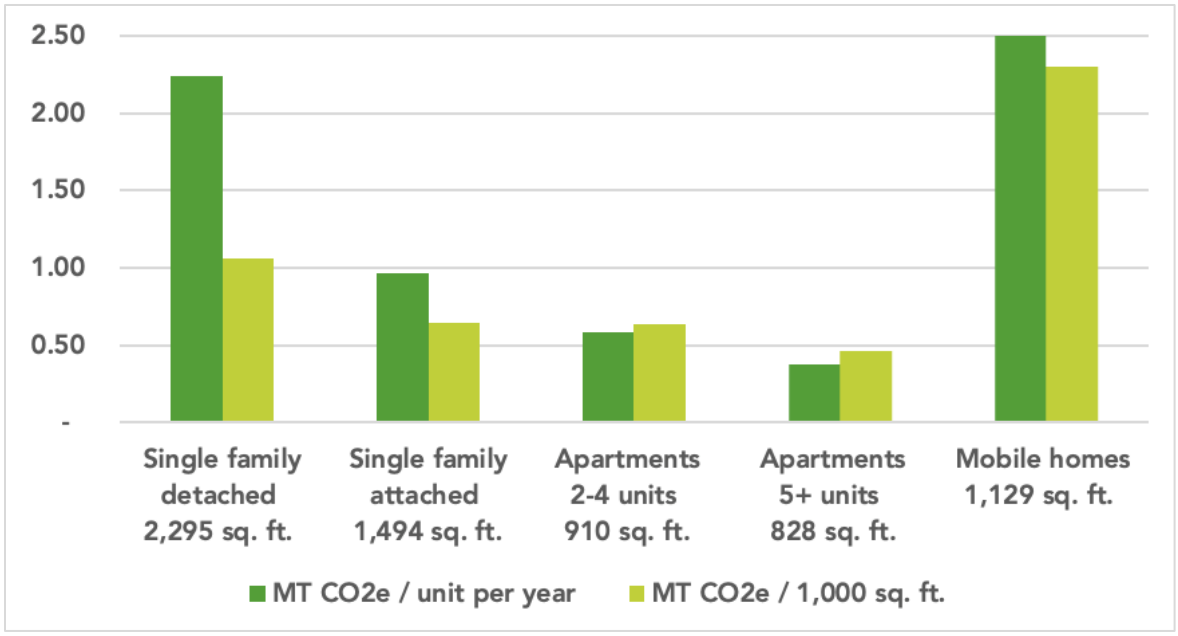


Figure 8: Greenhouse Gas Emissions per Housing Type in the City of Eugene

Publicly Supported Housing (Multifamily)

Publicly supported housing is defined as multifamily rental housing developments of five or more units receiving rental assistance. Oregon has 17,649 publicly supported housing units.[5]

Cooling Needs in Publicly Supported Housing (Multifamily)

Table 4 below displays the prevalence of functional cooling equipment by type in publicly supported housing. Note that this was a multiple choice "select all that apply" question and many respondents indicated that they had multiple types of cooling equipment.

Table 4: Prevalence of Functional Cooling Equipment by Type – Publicly Supported Housing (Multifamily)

Responses	Permanent			Temporary			Inadequate		
	Central AC	Central Heat Pump	Ductless Heat Pump	Window or wall AC	Portable AC	Swamp cooler*	Electric fans**	Shades or blinds	No cooling
#	104	36	26	163	114	24	193	97	25
%	25%	9%	6%	40%	28%	6%	47%	24%	6%

**Evaporation or swamp cooler*

***Ceiling or portable fans*

Table 5 shows survey findings on the percentages of residents living in publicly supported multifamily housing that have an immediate need, long-term need, or no new equipment needs based on the cooling equipment they indicated currently having.

Table 5: Cooling Needs for Publicly Supported Housing (Multifamily)

Publicly Supported Multifamily Cooling Need	Survey Responses	Projected % of total housing units	Projected # of total housing units
Immediate Need (Inadequate cooling only)	**85**	**21%**	**3,700**
Long-Term Need (Functional temporary cooling)	186	45%	8,000
No New Equipment Needs (Functional permanent cooling)	139	34%	6,000

Figure 9 illustrates the quality of cooling that works by region for publicly supported multifamily housing based on survey responses.

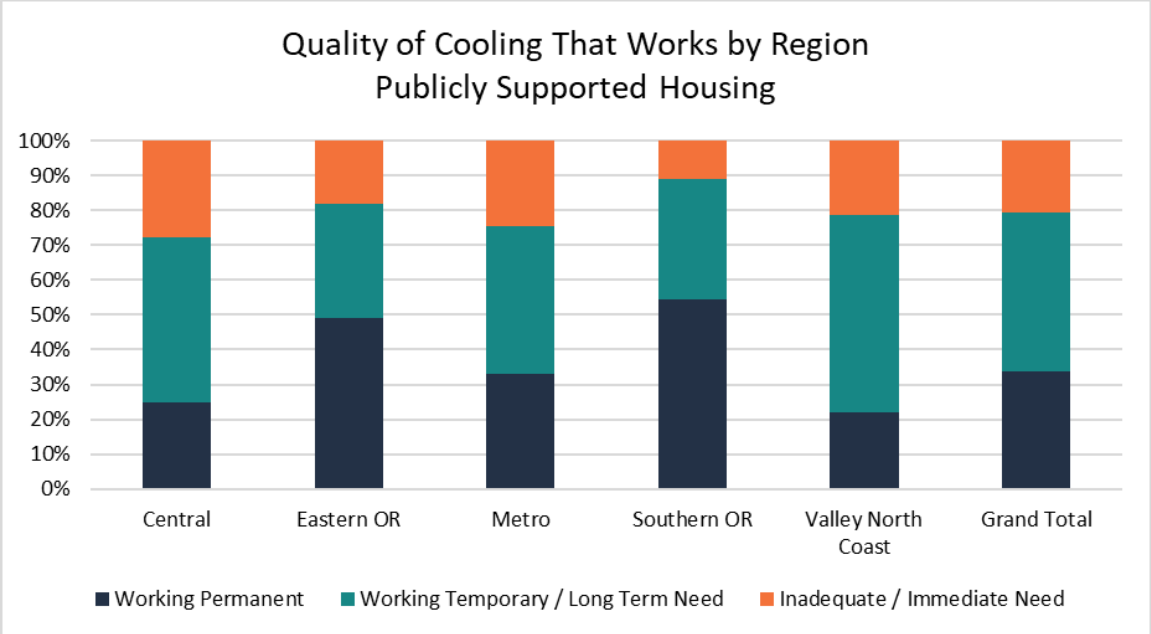


Figure 9: Quality of Cooling That Works by Region – Publicly Supported Housing (Multifamily)

Challenges for Meeting Cooling Needs in Publicly Supported Housing (Multifamily)

Structural challenges

- Variables such as story, window direction, and trees/building/landscape shade all contribute to variations in temperature per each unit.[6]

- Depending on the age of the building, electrical panels may not support the addition of air conditioning for the whole building or support individual window or portable units for cooling.[iv]
- As publicly supported housing units are exclusively rentals, electrical upgrades are the responsibility of the landlord and may be a costly and labor-intensive upgrade for property owners to take on.
- Retrofits to existing buildings must be examined on a case-by-case basis to determine the most efficient option based on whether ducting already exists and current inefficiencies in ducted systems.

Variances in Urban and Rural Locations

- Residents living in multifamily properties in urban environments are more likely to experience compounding impacts from the urban heat island effect[v] due to increased density and less nearby access to parks or green space. However, the density in urban environments may also contribute to increased access to community resources and more options for residents to relocate to cooling centers or air-conditioned public spaces on high-temperature days.
- Residents living in multifamily buildings in rural environments are likely to have greater access to parks and green space but may have fewer options for visiting cooling centers or air-conditioned public spaces and/or face longer travel distances to access these spaces in case of an emergency.

Equity and Cultural Considerations

Publicly supported multifamily housing is an exclusively rental housing type. This means that residents have less control over their homes and home systems, such as cooling. Residents may also have less control over their utility bills and the temperature within their unit if heating and cooling are controlled building wide. Landlords bear the burden of upgrading cooling systems but do not directly benefit from such upgrades unless they are able to pass the additional costs onto the tenants. Additionally, residents face more restrictive guidelines for installing their own cooling equipment in their homes.

To address cooling needs in publicly supported housing, programs must consider the needs of both residents and landlords/building owners. Interim solutions for this housing type could include designated cooling rooms for each floor or a cool space for the whole building used for

[iv] The Cooling Needs Study mapping tool identifies the number of multifamily housing units built pre-1980 statewide as a unique layer for pinpointing this issue.

[v] The urban heat island effect is when an urban area experiences much higher temperatures than surroundings due to lack of natural land cover that has been replaced with dense concentration of impervious surfaces, buildings, and other heat retaining surfaces. Learn more at https://www.epa.gov/heatislands/learn-about-heat-islands.

relief during extreme heat events. Weatherization programs could benefit whole buildings in keeping the spaces well insulated and cool, maximizing the efficiency of any cooling efforts.

Residential Recreational Vehicles

This housing segment is included in the study with the intention of understanding the needs of residents living permanently or semi-permanently in residential vehicles. A few specific scenarios of this type of dwelling are found statewide, including:

1) **Wildfire relief housing** – primarily in rural communities that are recovering from wildfires.
2) **Safe parking areas** – in response to housing shortages statewide and the increase of people experiencing homelessness.
3) **Dispersed parking** – in neighborhood driveways, on public streets, etc.

Note: this study does not include an analysis of cooling needs for people who are experiencing homelessness, and there is a need for further research to distinguish the gaps and overlaps between people living in RVs as permanent dwellings and people experiencing homelessness. This study does not fully capture this nuance.

Reliable data for this housing segment is challenging to obtain. The best available data source on the prevalence of this housing type is the American Community Survey data on the number of "RVs, Boats, and Vans" being used as housing. According to American Community Survey, 6,291 of these units exist statewide.

Due to the data challenges, the report takes a more place-based, case-study approach to illustrating the cooling needs for people living in RVs as permanent dwellings and highlights the issues faced by residents living in RVs in wildfire recovery communities.

Cooling Needs in Residential Recreational Vehicles

Of the 948 total responses received, 132 respondents (14 percent) live in RVs.

Table 6 below displays the prevalence of functional cooling equipment by type in residential RVs. Note that this was a multiple choice, "select all that apply" question, and many respondents indicated that they had multiple forms of cooling.

Table 6: Prevalence of Functional Cooling Equipment by Type – Residential RVs

Responses	Permanent			Temporary			Inadequate		
	Central AC	Central Heat Pump	Ductless Heat Pump	Window or wall AC	Portable AC	Swamp cooler*	Electric fans**	Shades or blinds	No cooling
#	45	14	8	44	43	16	58	52	9
%	34%	3%	2%	11%	11%	4%	14%	13%	2%

**Evaporation or swamp cooler*
***Ceiling or portable fans*

Table 7 shows survey findings on the percentages of residents living in residential RVs that have an immediate need, long-term need, or no new equipment needs based on the cooling equipment they indicated currently having.

Table 7: Cooling Needs for Residential Recreational Vehicles

Residential RV Cooling Need	Survey Responses	Projected % of total housing units	Projected # of total housing units
Immediate Need (Inadequate cooling only)	**28**	**21%**	**1,300**
Long-Term Need (Functional temporary cooling)	51	39%	2,400
No New Equipment Needs (Functional permanent cooling)	53	40%	2,500

Figure 10 illustrates the quality of cooling that works by region for residential recreational vehicles based on survey responses.

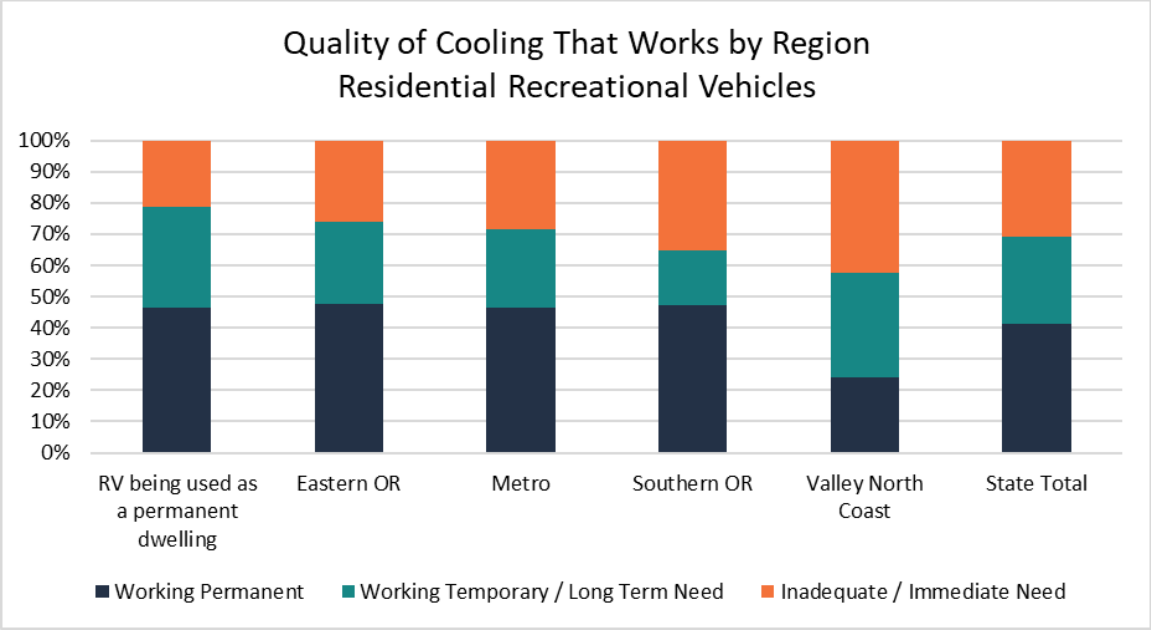


Figure 10: Quality of Cooling That Works by Region – Residential RV

Challenges for Meeting Cooling Needs in Residential RVs

RV homes pose their own unique challenges to consider in meeting cooling needs.

Housing Structures and Site Conditions Vary

- Lack of insulation can cause RVs to build up heat during extreme heat events.
- Not all residents living in RVs have consistent access to adequate power hookups.
- When power outages occur in RV parks, generators operate on limited capacity and propane fuel, which can be prohibitively expensive. This is increasingly frequent due to planned wildfire prevention outages and emergency events.
- Maintenance requirements are frequent and costly when using RVs as full-time housing.

Variances in Urban and Rural Locations

- Most RVs being used as long-term housing are located in rural communities.
- RVs in urban environments are less likely to have access to parking where they can leave their vehicle long term, although many urban jurisdictions are adopting safe parking programs. Residents living in RVs outside of specified RV parks may have less access to electricity/amenity hookups if they are dispersed on streets without a permanent location.
- Rural RV communities may have more access to shade and amenity hookups specifically for RVs. Rural areas are more likely to have open space and trees that could provide necessary shade to keep vehicles cool. That said, rural communities are subject to more frequent power outages and smoke and fire risk if they are adjacent to forests. Much of

the state is projected to experience an increase in the proportion of burned areas per year due to climate change.

McKenzie Valley Long-Term Recovery Group Case Study

The McKenzie Valley Long-Term Recovery Group is a nonprofit dedicated to the recovery of residents who lost their homes to the 2020 Holiday Farm fire in the McKenzie Valley. Currently, 80 to 90 RVs are being used as semipermanent wildfire recovery housing in the McKenzie Valley. Despite having this temporary solution, families might remain unhoused for a decade due to funding bureaucracy, land use restrictions, and lengthy contract and construction processes. The insights of MVLTRG offer valuable context for understanding cooling needs in RVs being used as permanent residences. *The full MLVTRG case study can be found in Appendix 2.*

RVs Are Not Designed for Use As Permanent Housing and Pose Cooling Challenges

RVs are not designed or suitable for long-term, permanent use as housing due to poor insulation, expensive cooling and heating costs, and burdensome maintenance demands. Almost all RVs in the McKenzie Valley have built-in air conditioning units, but while they are intended to last up to 10 years with recreational use, they are breaking down within one to two years in RVs being used for full-time housing. MVLTRG provided temporary air conditioning units to residents without functional cooling equipment but found these present challenges, including requiring frequent draining, which has the risk of overflowing and damaging an RV.

MVLTRG has also provided inflatable insulation for the underpinnings of RVs to help address poor insulation; however, this was found to be cumbersome and challenging to use, blocking essential undercarriage storage for residents.

Suggested Solutions to Meet Cooling Needs

MVLRTG suggests prioritizing the fixing of preexisting cooling equipment in residential RVs. The cost to repair existing units averages $1,700 to $4,000 per unit. Despite the cost, repairing the existing air conditioning systems best serves residents' needs for cooling and safety during extreme heat events. MVLRTG reported the RV parks they serve also face frequent power outages due to utility shutoffs for wildfire risk, pushing residents to rely on costly propane-powered generators for heating and cooling. MVLTRG has offered propane vouchers to aid residents with higher energy costs.

Equity and Cultural Considerations

Residents living in residential RVs are subject to poor insulation, expensive heating and cooling costs, and burdensome maintenance demands. RVs are not built for long-term use as housing and, in the case of wildfire recovery communities, the residents living in them are already living in precarious circumstances in the wake of disaster. Additionally, rebuilding periods can take up

to 10 years, and RV housing does not provide residents with opportunities to build equity through homeownership.

Agricultural Workforce Housing

This section aims to illustrate the needs of residents living in employer-provided agricultural workforce housing, commonly known as farmworker housing.[vi] This population is highly vulnerable to the impacts of extreme heat exposure, which is exacerbated when individuals are exposed to heat during the day and then return home to hot structures. Farmworker housing varies widely in location and type across the state. This study specifically focuses on employer-provided agricultural workforce housing, as it is the only segment designated and regulated solely for agricultural workers. *It is important to note that only about 13 percent of agricultural workers reside in employer-provided housing, according to a 2023 study conducted by the Oregon Housing and Community Services.*[7]

Agricultural workforce housing is found both on- and off-farm and takes many forms, including mobile/manufactured homes, shared dormitory style housing, and cabins.

Data Limitations

The data available for employer-provided agricultural workforce housing have limitations. The best available data source on the prevalence of this housing type is the Oregon Occupational Safety and Health Ag Labor Housing Registry. The registry includes all registered employer-provided agricultural workforce housing units with six or more occupants.

According to the Ag Labor Housing Registry, 488 addresses accommodate up to 14,385 maximum occupants statewide.

This registry does not include units occupied by members of the same family, units with five or fewer beds, or single-family homes. The actual number of occupants in any given unit at any given time cannot be determined but can be estimated based on information provided annually to the Oregon Occupational Safety and Health Division when employers and operators renew their registration and/or the maximum allowable occupancy, per Oregon OSHA rules. The actual agricultural workforce housing occupancy fluctuates statewide and year-round along with the workforce due to the seasonality of the work and availability and issuance of H-2A visas.[vii] Registered agricultural workforce housing units may be occupied anywhere between a

[vi] This housing type was not included in the Oregon Cooling Needs Survey, and the findings in this section are based solely on research and expert interviews (described in Appendix 1).

[vii] The temporary H-2A agricultural program allows employers to bring foreign workers to the U.S. for temporary seasonal work when there is not an adequate supply of U.S. workers available. H-2A units are flagged in the Ag Labor Registry and inspected separately by the Oregon Employment Department as well as Oregon OSHA.

week and a full year. Based on the wide variance in size and type of dwelling at each address, this study assumes that the average dwelling unit houses seven occupants.

Due to the data challenges, this study takes a qualitative research approach to describe the landscape and cooling needs for people living in employer-provided agricultural workforce housing. The research highlights the issues and opportunities for addressing cooling needs in this housing type.

Agricultural Workforce Housing Current Cooling Policies and Regulations

High Ambient Temperatures in Labor Housing

Effective June 15, 2022, Oregon OSHA updated its regulations regarding heat and cooling in employer-provided agricultural workforce housing to help prevent heat-related illness among farmworkers. Current regulations require that the following accommodations be provided when it's 80°F or more outside and sleeping quarters cannot be kept at 78°F or below.

Cooling Areas

Employers must provide at least one cooling area for occupants to cool off. The cooling area must be large enough to be used by at least 50 percent of the occupants at any given time. These areas can be either a common space or an outdoor rest area.

- Common Space: Common spaces must be kept at 78°F or below (by functional air conditioning equipment or other reliable means). This can be done with existing common rooms, unoccupied units, or other available indoor space on the premises.
- Outdoor Rest Area: Outdoor rest areas must have unrestricted access and must provide shade, be away from work activities, provide seating, and have additional mechanisms to keep workers cool (water misters, cooling towers, cooling towels, cooling vests, etc.).

Minimizing Heat in Housing Units and Temperature Awareness

Employers must provide window coverings that protect sleeping rooms from direct sunlight. These coverings must deflect heat, and fans must also be available and provided free of charge to occupants. Additionally, employers are required to provide thermometers in each housing unit that display temperatures in Fahrenheit and Celsius for residents to know current indoor temperature at all times.

Inspections and Enforcement

Agricultural workforce housing units are inspected for compliance with Oregon OSHA regulations when they are first registered and when/if they increase the number of occupants. Otherwise, inspections and enforcement rely on random selection or responding to formal complaints and referrals.

Enforcing the standards for cooling is particularly challenging because Oregon OSHA compliance visits tend to occur in the spring, prior to when housing units are occupied. This makes it

difficult to assess whether cooling systems are adequate during more extreme temperatures. Relying on a system of complaints also puts workers in the vulnerable position of risking their employment and housing status should they raise concerns.

Conversely, employers who have been cited for not adhering to housing standards may not have the means to upgrade spaces or provide the necessary repairs to meet current regulatory standards. Many agricultural employers in the region are operating on tight margins and don't have the capital for the high upfront costs of improvements.

Interagency Task Force and Rulemaking Underway

Interagency Task Force on Agricultural Labor Housing

Governor Kate Brown launched the Interagency Task Force on Agricultural Labor Housing in 2022 to implement changes and improvements for employer-provided agricultural workforce housing statewide.[8]

The task force was convened to specifically focus on three areas:

- Coordinating compliance**:** Clearly defining responsibilities and territories for enforcement efforts.
- Capital Improvements: Providing investments for improving the conditions of existing employer-provided housing infrastructure including structural upgrades, improved sanitation, and water.
- Infrastructure and Statewide Issues: Upgrading local zoning regulations, electrical infrastructure, and water rights.

The Task Force provided recommendations to the Governor's office in November 2022, including continued discussions and information sharing around health and safety concerns, supporting a new $5 million grant program dedicated to updating on-site farmworker housing, and continuing efforts by the Agricultural Workforce Housing Facilitation Team at Oregon Housing and Community Services to address issues in employer-provided agricultural housing.

Oregon OSHA Rulemaking Process Currently Underway

While the existing policies and regulations do not comprehensively meet the cooling needs for all agricultural workers, an Oregon OSHA rulemaking process is underway that aims to address cooling needs to a greater degree. The current rulemaking process began in 2018 and includes a full rewrite of all the rules for agricultural workforce housing. Air conditioning is being considered in this process, and a proposal is expected to be published by early spring of 2024.

Although new rules are expected to help better meet the cooling needs in this housing type, it is important to note that anything that would require a building permit is likely to have a delayed effectiveness date given the challenges associated with acquiring permits, especially in rural areas. Once new rules are effective, Oregon OSHA would immediately perform

inspections, but only for those regulations that are currently in effect. Because of this, it may be several more years before updated cooling requirements are both in effect and enforceable.

Some considerations regarding updating the cooling requirements include:

- Concerns from growers and grower advocates about the upfront and ongoing costs associated with cooling equipment.
- The need for (and associated cost of) electrical infrastructure upgrades.
- What requirements to set for temperature, length of time, and coverage. The rules need to be feasible/attainable, and even the best managed systems can only handle so much heating load when temperatures are extreme.

Cooling Needs in Agricultural Workforce Housing

Existing agricultural workforce housing varies greatly with many old bungalows and dormitory style units with electrical systems that do not meet the requirements for cooling equipment, and some newer manufactured home units with air conditioning already installed. That said, given increasing temperatures and the Oregon OSHA rulemaking process currently underway that is likely to increase the level of required cooling in agricultural workforce housing, **this study assumes that all units of employer-provided agricultural workforce housing will require electrical and equipment upgrades to fully meet the long-term cooling needs of the occupants.**

The total cost for installing the preferred cooling equipment in agricultural workforce housing is estimated to be $22,300,000 to $36,500,000.

In addition to cooling equipment, a number of broader issues regarding agricultural workforce housing must be addressed:

- General lack of housing supply and overcrowding in existing units
- Poor living conditions (such as labor camps/tents)
- Water infrastructure challenges
- Insufficient insulation/weatherization causing high ongoing energy costs

Funding Opportunities and Gaps

Agricultural Workforce Housing Tax Credit Program

The primary existing funding source for facilitating upgrades to housing for agricultural workers in Oregon is the Agriculture Workforce Housing Tax Credit Program. This program offers a state income tax credit to employers who invest in constructing, installing, acquiring, or rehabilitating housing for agricultural workers.

- The tax credit is applicable to 50 percent of the eligible costs incurred or paid for completing a farmworker housing project. The total available credits for each two-year period amount to $16.75 million, with a specific allocation of 10 percent annually for

on-farm projects. Notably, the entire credit can be transferred to a contributor of the project.[9]

- This funding source can be used for improvements such as cooling equipment, weatherization, and electrical panel upgrades.
- While a helpful option, only about 20 percent of the total $16.75 million allocated to this program per biennium is being used.[viii] The tax credit system relies on the employer providing upfront costs for upgrades, which many are unable to do. Additionally, the tax credit system does not provide support for increased ongoing electricity costs, such as those associated with upgraded cooling (or heating) equipment. Ongoing costs are a large concern for employers who are unable to offset them via rental income because they are primarily providing housing at no cost to farmworkers.

Agricultural Workforce Housing Grants

Section 67 of House Bill 2001 allocated $5 million for the Oregon Department of Agriculture to establish a grant program to help employers improve the health and safety conditions of existing agricultural workforce housing. This program is still in development but is expected to have some limitations on what the funding can be used for, including the following:

- Funding is specific to existing housing (cannot be applied to new construction).
- Funding must be allocated for housing for domestic workers only (not including migrant workforce or H-2A housing).
- HB 2001 does not specify whether this funding could be applied to subsidize the energy costs of operating new cooling equipment.

Beyond the Agriculture Workforce Housing Tax Credit program and the forthcoming Oregon Department of Agriculture grant program, limited options exist for providing funding for employers to upgrade agricultural workforce housing.

PART II – Investment Needed to Meet Statewide Cooling Needs, Preferred Solutions, and Additional Considerations

This section outlines the costs and implications of meeting the statewide cooling needs. Accurately estimating costs for statewide implementation is challenging. Pricing for these interventions is dynamic and location specific and sensitive to supply chain disruptions, labor shortages, and inflation. The following high-level estimates are provided for sense of scale but are subject to significant change depending on the assumptions made. These calculations are purposefully kept at a high level to allow for full transparency and are meant to facilitate discussions of costs and the various components to be considered. These costs are large in scale

[viii] Per conversations with OHCS staff.

and will affect households across Oregon as they are implemented, but they also represent significant economic opportunity and job creation for local businesses and contractors.

According to survey findings, 58 percent of residents living in the housing types included in this study[ix] do not currently have adequate permanent cooling equipment. The overwhelming majority of residents are interested in improving their cooling systems, as shown in Figure 11.

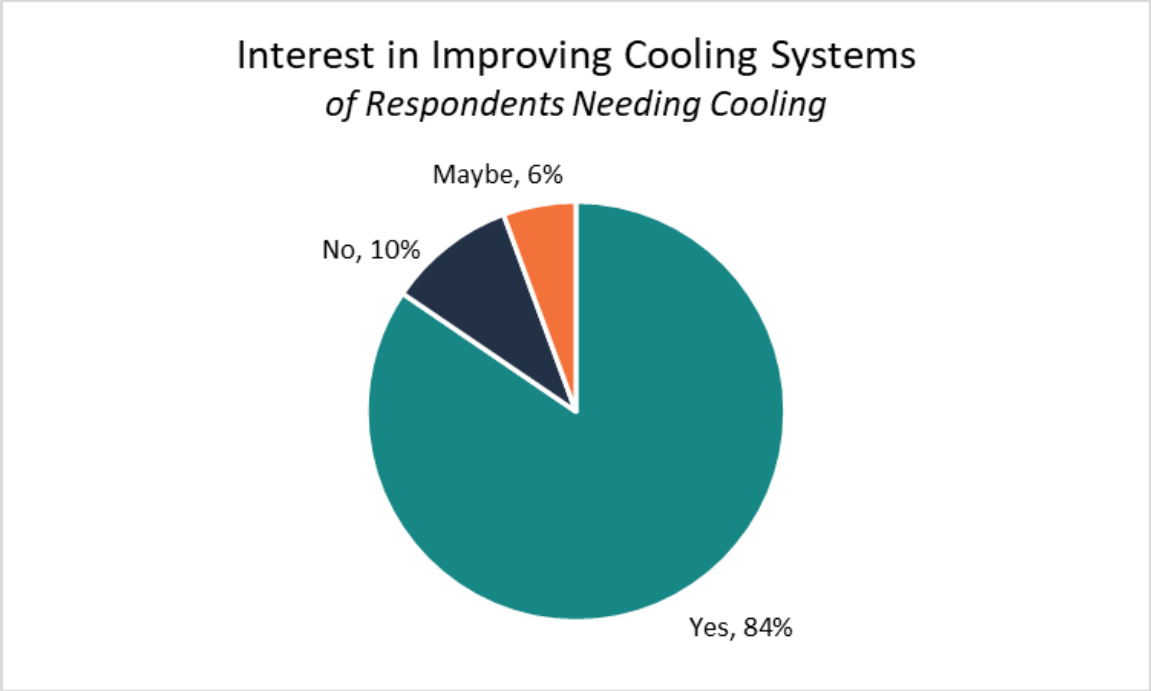


Figure 11: Resident Interest in Improving Cooling Systems of Respondents Needing Cooling

It is also important to note that, while this study is focused on the cooling needs of Oregonians living in the housing types most vulnerable to heat, it is more cost effective, energy efficient and safer for residents in the long run to consider cooling, electrical, and weatherization upgrades together and to implement these upgrades concurrently versus one at a time. Additionally, the preferred solution of prioritizing energy efficient electric ductless heat pumps would provide both cooling and heating, which is a similarly important need and burden in vulnerable housing types statewide given that Oregon's climate primarily requires heating.

[ix] Not including agricultural workforce housing.

Investment Needed to Meet Statewide Cooling Needs

To estimate the investment needed to meet the state's cooling needs, the study created two scenarios for each housing type, including the type and sizing of cooling equipment, with additional allowances for building envelope upgrades or minor repairs needed to support the installation of cooling equipment (Figure 12). *See Appendix 1 for cost scenario methodology.*

- **Comprehensive Cooling (Comp)**: Installation of permanent cooling equipment to properly cool the full living space in each housing unit: **$1,082,700,000**.
    - Manufactured, multifamily, and ag housing: Ductless heat pumps – one zone per bedroom plus one zone for common spaces.
    - RV: Permanent air conditioning – one per housing unit.
- **Health and Safety Baseline (H&S)**: Estimation of a baseline level of cooling equipment to avoid the worst effects of increased extreme heat events: **$604,400,000**.
    - Manufactured, multifamily, and ag housing: Ductless heat pumps – one zone per housing unit.
    - RV: Temporary air conditioning – one per housing unit.

The total cost for installing the preferred cooling equipment across all housing types is estimated to be $604,400,000 to $1,082,700,000.

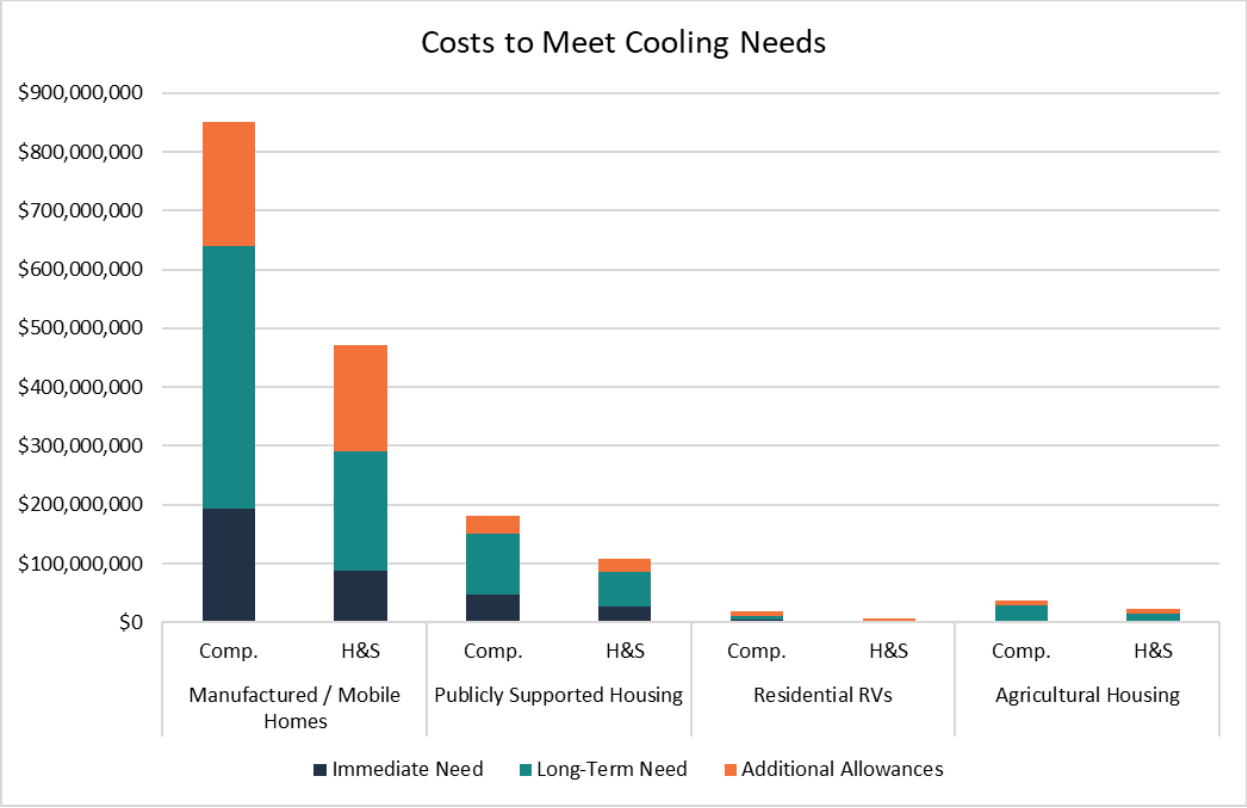


Figure 12: Total Costs to Meet Statewide Cooling Needs per Housing Type and Scenario

Table 8 provides a detailed cost breakdown of meeting the statewide cooling needs (as displayed in Figure 12) by cooling scenario, housing type, and immediate versus long-term needs.

Table 8: Detailed Cost Breakdown of Meeting Statewide Cooling Needs

Type of Housing	Units in Need of Cooling		Comprehensive Cooling Cost (2023 dollars)	Health and Safety Baseline Cost (2023 dollars)
	%	#		
Manufactured/ Mobile Homes	**50%**	**39,500**	**$851,000,000**	**$470,800,000**
Immediate Need	15%	11,900	$255,700,000	$141,500,000
Long-term Need	35%	27,600	$595,300,000	$329,300,000
Publicly Supported Multifamily Housing	**66%**	**11,700**	**$177,800,000**	**$105,300,000**
Immediate Need	21%	3,700	$55,800,000	$33,000,000
Long-term Need	45%	8,000	$122,000,000	$72,300,000
Residential RVs	**60%**	**3,800**	**$17,400,000**	**$6,000,000**
Immediate Need	21%	1,300	$6,200,000	$2,100,000
Long-term Need	39%	2,400	$11,300,000	$3,900,000
Ag Housing (Long-term Need)	**100%**	**2,100**	**$36,500,000**	**$22,300,000**
Statewide Total	**58%**	**60,000**	**$1,082,700,000**	**$604,400,000**
Immediate Need	18%	18,900	$317,700,000	$176,600,000
Long-term Need	40%	41,100	$765,000,000	$427,800,000

Note: some lines may not sum to total due to rounding.

Preferred Equipment Solutions

This study recommends electric heat pumps as the preferred solution for multifamily, manufactured/mobile homes, and ag housing because they use less energy, provide both cooling and heating, are cheaper to operate than other types of air conditioning equipment, and the state has already chosen to invest in heat pumps as a solution for cooling issues.

The most common and often least-expensive type of electric heat pumps are air-source heat pumps, which use electricity to operate the compressor that transfers heat indoors/outdoors (providing heating and cooling). Air-source heat pumps can work with a home's existing ductwork or be ductless. In most cases, ductless heat pumps are the preferred type of heat pump equipment because ducting can result in extra expenses and sealing/building envelope or air quality issues. However, in certain cases where ducting is already present, ducted heat pumps may be the most efficient option.

While electric heat pumps are the preferred solution for meeting the cooling needs statewide, further user education, along with heat pump deployment programs, is important to help residents understand their benefits and usage.

Table 9 below outlines all cooling equipment options evaluated for this study.

Table 9: Cooling Equipment Options, Considerations, and Costs

Equipment	Housing Type(s)	Considerations	Cost
Electric heat pumps Ducted or ductless configurations. Ductless heat pumps come in single or multiple zones.	Multifamily Manufactured Mobile Ag housing	Dual heating and cooling addresses year-round extreme weather events. Savings on *heating* costs of up to 50% compared to electric resistant heat from the winter months can help offset the cost of the added summer cooling. Ducted heat pumps can be costly or infeasible based on structure architecture. Ductless heat pumps do not require duct work and temperature can be regulated per unit. Heat pumps have no on-site emissions and are more efficient than electric resistance heat, which aligns with statewide decarbonization efforts.	Varies based on zone and capacity: $7,300 for single zone to $27,500 for 5 zones

Equipment	Housing Type(s)	Considerations	Cost
Central AC Central systems that use closed circuits of refrigerated air to keep buildings cool. Most central AC systems consist of outdoor and indoor units working in tandem.	Multifamily Manufactured Mobile	Adding ducts can be costly or infeasible based on structure architecture. Allows the owner to control energy costs. Can be challenging to achieve comfort for all residents.	$57,000 – $180,000 (entire apartment building)[10] $4,000–$8,000 per unit for side-by-side duplex, triplex, or fourplex properties[11]
RV Central AC Roof-mounted equipment manufactured for RVs.	RV	Designed for recreational use, these units tend to require repair every 1 to 2 years with full-time use.	$1,700–$4,000 to repair existing units
Portable AC Small mobile units that vent out a window and can cool a small space.	Any	Uses window space. Water collection reservoir requires emptying.	$100–$500 per unit
Window or Wall AC Small units that sit in a window (or are installed in the wall) and cool a small space.	Any	Uses window space. May conflict with window escape requirements in units with limited windows. Generally, require less energy than permanently installed AC equipment, but operate less efficiently. Window or wall ACs are typically sized for one room rather than a whole unit.	$150–$800 per unit

The State of Oregon is already implementing two heat pump programs statewide based on their various benefits.

- A $10 million statewide Community Heat Pump Deployment Program prioritizes assistance to environmental justice communities, individuals who rely on bulk fuels (e.g., liquified petroleum gas, propane, coal, and wood) or electric resistance heating, or individuals who reside in a home or structure that does not have a functioning heating or cooling system.
- A $15 million Oregon Rental Home Heat Pump Program works with contractors installing heat pumps for owners of rental homes as well as for manufactured homes or

RVs located in a rented space. The program includes a set-aside of funding specifically for low- and moderate-income renters/residents.

More information about currently available financial incentives, programs, and resources provided by utilities, local governments, and nonprofits are described in Appendix 4.

Electric Service Upgrades and Weatherization

In addition to cooling equipment, many of the housing units included in this study need electric service and weatherization upgrades. Electrical service upgrades are needed in many older homes for residents to have adequate power to operate cooling equipment. *Note that electrical loads will grow as household items, transportation, and heat are electrified. Panel upgrades in all buildings (other than the newest construction) are likely to be part of the costs of retrofitting.*

Weatherization upgrades are an important consideration for meeting overall cooling needs and health and safety standards in residential buildings, especially for older manufactured/mobile homes that often have poor building envelopes and may not be energy efficient in their design. Weatherization helps make residents safer in extreme heat (and cold) events and make homes require less energy. This benefits the community as a whole because it can reduce the need for utilities to expand their capacity to meet the need of additional cooling equipment, which, in turn, saves money on ongoing utility costs for residents. Weatherization can also help limit the likelihood of mold growth in the home.

Specific Scenarios for Publicly Supported Multifamily Properties in Development or Preservation to Add Cooling Facilities

- The comprehensive cooling scenario is recommended for multifamily properties in development and includes ductless heat pumps with one zone per bedroom and one zone for common spaces.
- For properties in preservation, where it is not feasible to install ductless heat pumps, the recommendation is to either provide temporary cooling equipment to address residents' immediate cooling needs and/or consider the additional actions that complement unit-by-unit cooling, as described below.

Additional Cost Considerations

Increased Utility Costs for Residents

ODOE estimates that air conditioning costs are typically 10 to 15 percent of a household's annual energy bill and that installing new cooling equipment could increase a household's utility use by the same 10 to 15 percent. Window and portable units tend to be less efficient and could therefore increase costs even more. While this could be a significant increase in utility costs for lower-income residents, heat pumps are very efficient for heating and could reduce wintertime energy costs, which could then help offset increased summertime cooling

costs. Ductless heat pumps provide savings on heating costs of up to 50 percent compared to electric resistant heat.

Costs of Public Education and Outreach

While not quantified for this study, adequately meeting the cooling needs of Oregon residents requires additional costs for public education and outreach in addition to the cost of equipment installation. Education is needed to inform residents about the following:

- Energy efficient use of cooling equipment.
- Behaviors (such as opening and closing windows and blinds) that can reduce indoor air temperatures.
- Benefits of ductless heat pumps for energy efficiency and cost effectiveness (for heating).
- Heat health and safety; how to avoid heat-related illness.

On-the-Ground Capacity Needed for Implementation

Alongside public education and outreach, on-the-ground capacity is needed to support residents through the processes of working with contractors, selecting equipment, accessing funding sources, and so forth. Figure 13 illustrates the types of help survey respondents indicated needing to improve their cooling systems.

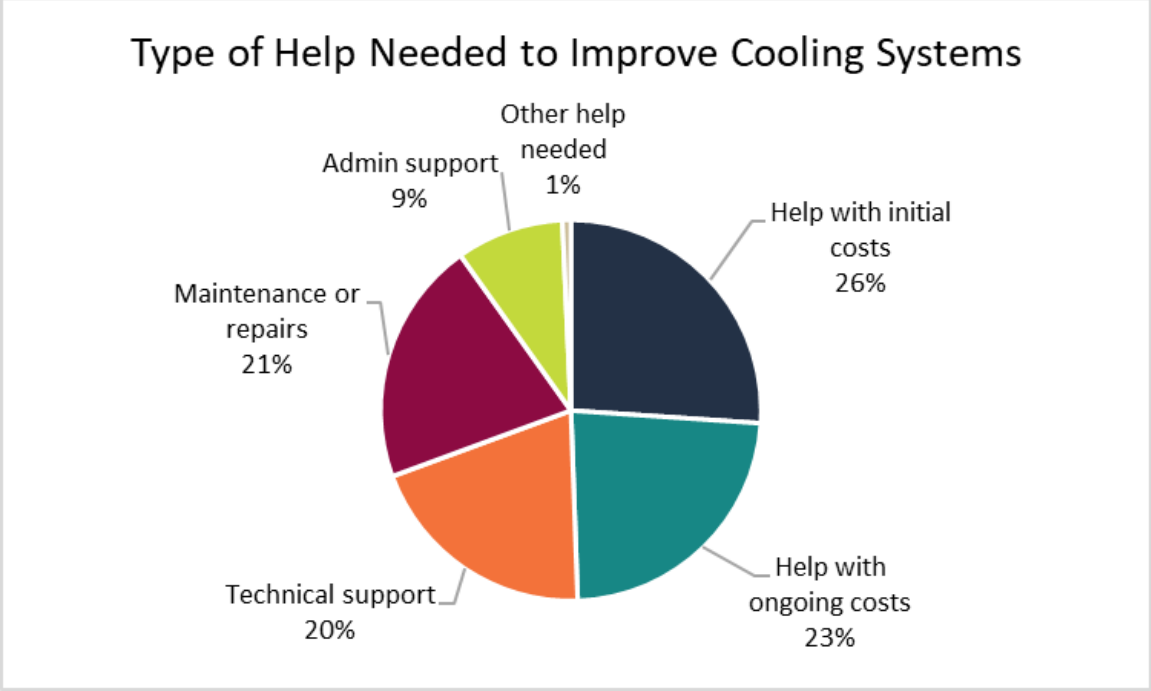


Figure 13: Types of Help Needed to Improve Cooling Systems

Additional Actions that Complement Unit-By-Unit Cooling Equipment

Beyond cooling equipment, electrical upgrades, and weatherization, other opportunities to help residents stay safe and cool include:

Passive Cooling

Passive cooling is the term for design strategies to reduce heat gain and increase heat loss. Examples of passive cooling interventions include:

- Cool roofs – The U.S. Department of Energy suggests cool roofs as an energy efficient solution for passive cooling interventions. Cool roofs are "designed to reflect more sunlight than a conventional roof, absorbing less solar energy . . . Conventional roofs can reach temperatures of 150°F or more on a sunny summer afternoon, sun [sic]. Under the same conditions a reflective roof could stay more than 50°F (28°C) cooler. This can save energy and money in buildings with air conditioning or improve comfort and safety in buildings without air conditioning, by reducing heat flow from the roof into the occupied space."[12]
- Deciduous shade – Deciduous shade and tree canopy have also been shown to lower temperatures in buildings. However, this depends on building height and level of tree canopy and is a longer-term solution given the time it takes for trees to grow to maturity.
- Outdoor shade structures – Outdoor shade structures could be installed quickly and affordably to provide respite near buildings and neighborhoods that do not have access to existing green space and shade.

Expanding Water Access

Expanding water access could be a short-term, low-cost, lifesaving intervention to help residents stay cool and hydrated when they do not have access to adequate cooling equipment in their homes. Easy to implement water access options include:

- Portable pools.
- Hydration stations.
- Misters and splash pads.

Community Cooling Facilities and Emergency Cooling Shelters

Cooling shelters provide an opportunity for keeping a large group of people safe and cool during an extreme heat event, specifically populations who are mobile (not homebound and have access to transportation). These cooling shelters can range in size and structure, such as libraries, community centers, or a common room in an apartment building. Definitions from Multnomah County for different types of cooling facilities include:[13]

- **Cooling Space**: An air-conditioned location open to the public, with water often available. These spaces are open only during the hottest part of the day and do not operate 24 hours a day. Community partners, such as houses of worship, may operate cooling spaces.
- **Cooling Center**: A location with air conditioning, cooling resources, water, food, and support services. These locations operate only during the hottest part of the day.
- **Cooling Shelter**: A location with air conditioning, cooling resources, water, food, and support services. These locations are similar to cooling centers but operate 24 hours a day.

Survey results indicate that many residents are unaware of emergency cooling centers, as shown in Figure 14. Of those who are aware, few have used them during extreme heat events. Our CBO partners indicated that residents are more likely to use more localized cooling centers, such as building-level or RV park-level centers, than community-level centers.

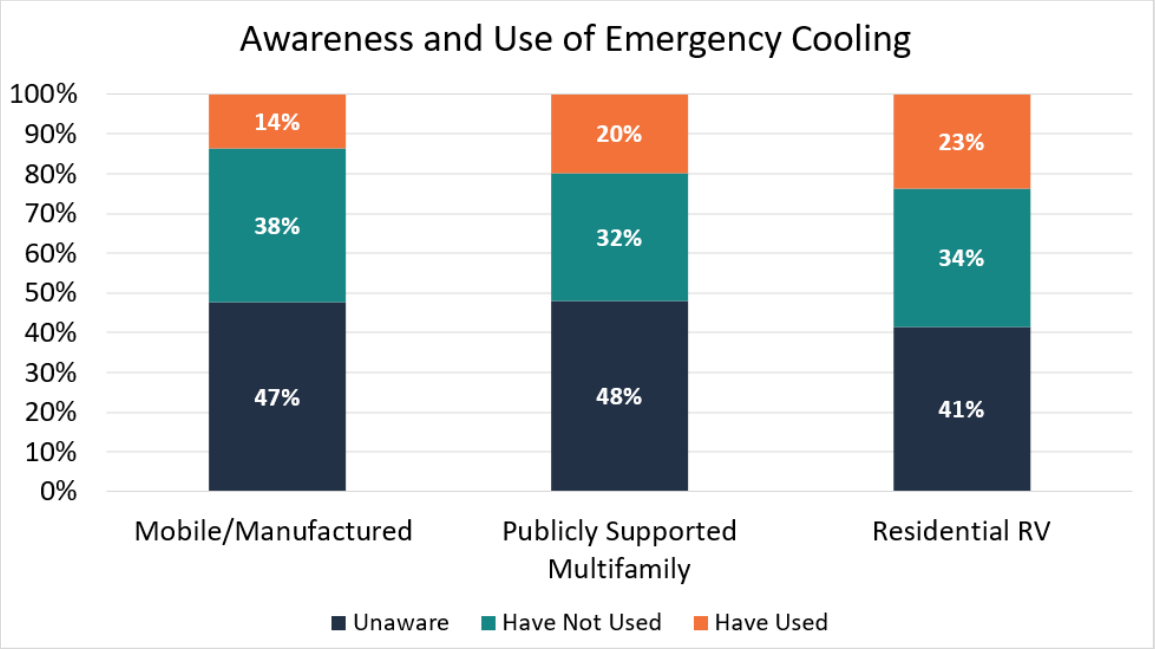


Figure 14: Awareness and Use of Emergency Cooling Shelters

On-site cooling spaces for manufactured/mobile home parks and multifamily buildings could be a good solution for meeting residents' cooling needs in the short term and in cases where installing unit-by-unit cooling is not feasible.

- Providing air conditioning for common spaces at manufactured/mobile home and RV parks is a recommended short-term solution to protect communities during extreme heat events.

- This strategy can also be used for multifamily buildings with common space available as an immediate intervention and/or in cases where it is not feasible to install equipment on a unit-by-unit basis.
- Onsite cooling spaces with backup power could provide relief for residents in the case of a power outage if each individual unit does not have adequate backup power.

Part III - Heat Vulnerability and Community/Cultural Context

This section describes additional considerations beyond cooling equipment for protecting the health and safety of Oregon residents in the face of increasing temperatures. Identifying populations with the greatest vulnerabilities to heat and heat-related illnesses is essential, from an equity and environmental justice lens, for decision-makers to understand social behaviors and barriers that limit access to cooling and target programmatic efforts. This is especially important for protecting the health and safety of residents most vulnerable to heat in the short-term as Oregon works toward ensuring all housing units have adequate cooling equipment installed.

Understanding Heat Vulnerability

The Heat Vulnerability Index is an interactive, online GIS tool created to geographically identify and numerically measure the relative vulnerability to heat impacts across counties and census tracts. The index synthesizes existing data and uses a standardized scoring system to allow for statewide comparison and analysis. This tool was created alongside this study to inform policy decisions and lay the foundation for further analysis.

The Heat Vulnerability Index visually displays all counties and census tracts and their relative vulnerability "scores" as a heat map. The scoring for the index was determined by standardizing each indicator by dividing the indicator value by the max value to receive a score between 1 and 100. Higher scores indicate higher vulnerability and areas in need of prioritized action. The Heat Vulnerability Index is composed of 23 different indicators that are organized into three separate indexes: Exposure, Sensitivity, and Adaptive Capacity. All three indexes are averaged to create the overall Heat Vulnerability Index. These indexes overlay the interaction of physical sensitivity to heat and illness, level of exposure to extreme heat, and ability to adapt and recover from exposure events. *Note: Although not all these indicators are specifically tied to increased likelihood for experiencing heat-related illness, they are compounding factors in the challenges associated with accessing cooling resources and recovering from exposure events.*

The indexes are described as follows:

1. **Exposure** indicators are used to anticipate potential heat exposure in the future based on historic and projected data.

2. **Sensitivity** indicators include age and health conditions that affect the degree to which a population may be affected by heat exposure.
3. **Adaptive Capacity** indicators include sociodemographic and geographic indicators that can affect people's ability to cope with change. This includes identification of communities that have been historically disadvantaged due to discriminatory practices and policies. Due to historic systems of oppression and underlying sociological, economic, and political drivers that have perpetuated inequalities, low-income households and communities of color continue to be disproportionately exposed to higher levels of pollution and thus have higher rates of physiological risk factors regarding heat exposure.[14]

Additional layers are included for reference in the Heat Vulnerability Index tool but are not included in the scoring to avoid redundancies and because this study is focused on housing types on a statewide scale. *Details of the Heat Vulnerability Index methodology are provided in Appendix 3.*

Heat Vulnerability Index Findings

The results of the Heat Vulnerability Index are displayed in Figure 15. Higher scores indicate higher vulnerability to heat exposure and related impacts. The average county heat vulnerability index is 57.

Further description of the results for the heat vulnerability index, exposure index, sensitivity index, and adaptive capacity index can be found in Appendix 3.

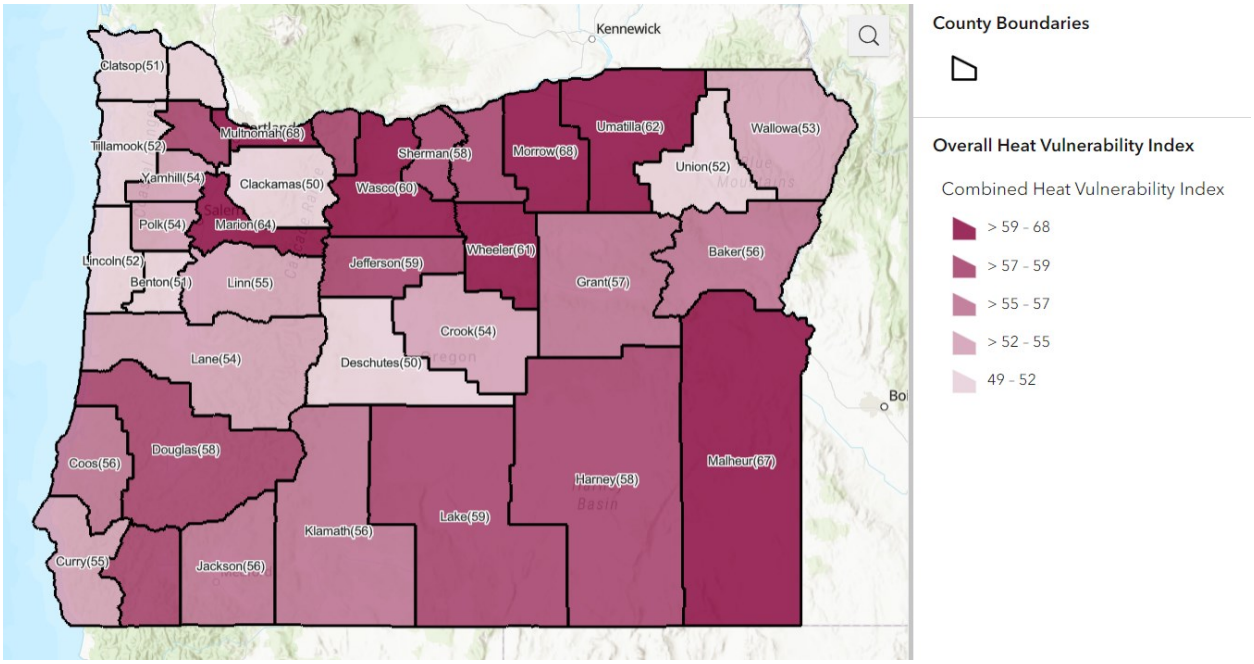


Figure 15: Map of Overall Heat Vulnerability Index Results

Table 10 below displays the top six counties that rank highest on the overall Heat Vulnerability Index.

Table 10: Top Six Counties Ranking Highest on the Heat Vulnerability Index

Top 6 Most Vulnerable Counties	Overall HVI Score
Morrow County	68
Multnomah County	68
Malheur County	67
Marion County	64
Umatilla County	62
Wheeler County	61

Addressing Programmatic Barriers to Better Serve Diverse Populations

Beyond the needs for cooling equipment, Oregonians face additional barriers in accessing and using existing resources and services. This section highlights findings from the Cooling Needs Study survey, feedback from interviews with CBO partners, and key takeaways from case studies (see Appendix 2). This is a high-level summary of key barriers and opportunities to improve equitable access to cooling resources.

Lack of Awareness and Accessibility of Existing Programs

Survey respondents and CBO partners expressed concerns about the lack of awareness around existing programs. Figure 16 outlines survey findings for reasons why respondents have not used assistance programs (utility assistance, cooling shelters, or upgrade programs).

Oregon Rural Action shared that residents become overwhelmed with program applications that include multiple steps and are less likely to complete the process. Additionally, information distributed predominantly online may not be accessible for older residents or those living in rural communities with unreliable internet access.

These barriers pose an opportunity to improve connectivity to programs through door-to-door, face-to-face outreach via trusted ambassadors to inform residents about existing programs and assigned case managers to walk residents through the application process and continue with follow-up appointments.

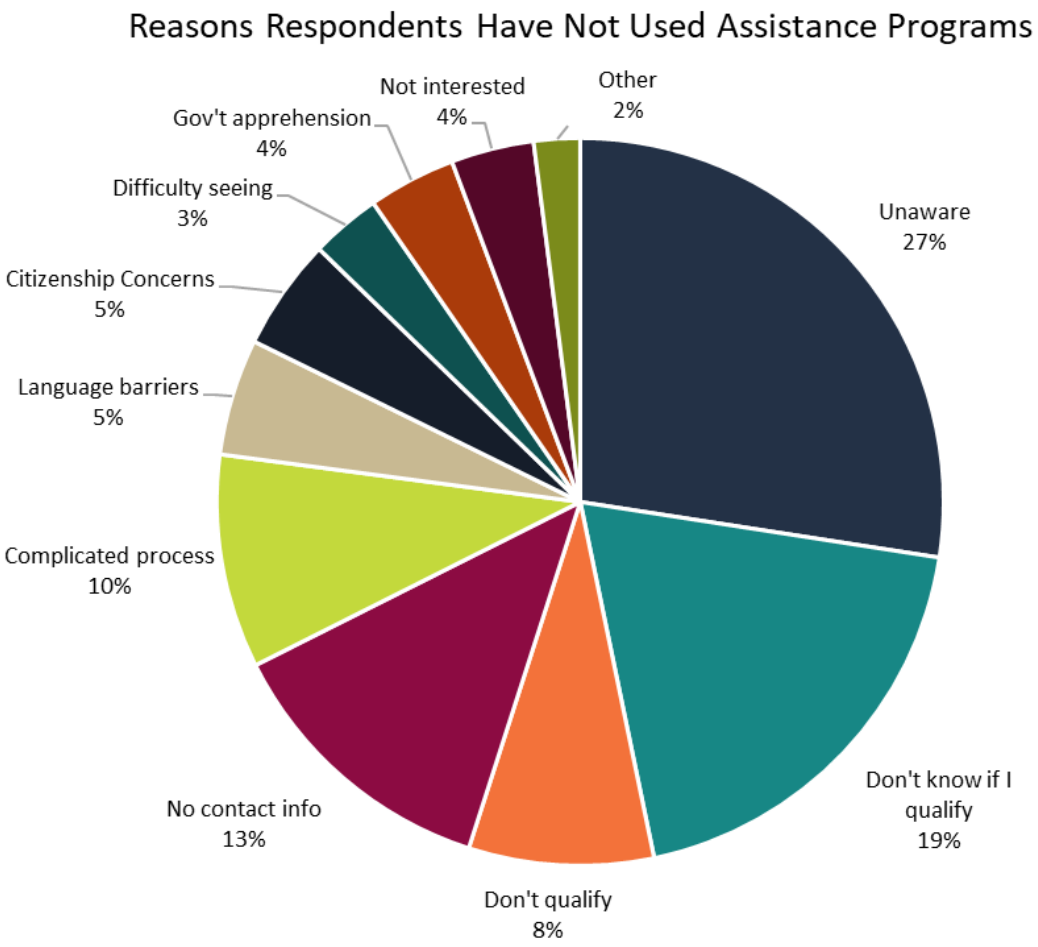


Figure 16: Reasons Respondents Have Not Used Assistance Programs

Language Barriers and Digital Literacy

Many survey respondents and CBO partners including Unete, through their work serving Spanish-speaking communities, expressed a need for more transcreation and multilingual resources to increase the awareness of available resources. Additionally, access to online materials is limited to those with digital literacy, referring to a person's ability to navigate and access information on digital media platforms. Individuals without digital literacy face significant challenges accessing useful online information and resources.

Cost of Energy Use

Many residents shared that they do not use existing cooling equipment due to energy costs. Financial limitations were the primary factor cited in the survey preventing residents from using their air conditioning equipment. This is further exacerbated by poorly insulated, inefficient structures commonly found in older RVs and manufactured homes that perpetuate cost burdens for residents who may be already struggling with affording rent, medical, and utility bills. Within this context, air conditioning is often seen as an unaffordable luxury versus a basic need.

Energy assistance and weatherization programs provide relief to residents facing financial barriers to meet their cooling needs. Weatherizing homes along with providing cooling equipment upgrades can alleviate the additional burden of energy consumption for cooling. Both Verde and Lake County Resources Initiative expressed the importance of weatherization upgrades alongside cooling equipment installation.

Narrow Eligibility Requirements Limits Access Among Those in Need

Survey respondents and CBO partners described how narrow eligibility requirements for programs exclude many residents in need. Unete specifically noted cases of residents who live alone and those who do not qualify for Medicare as not having access to specific programs and services. This poses an opportunity to reevaluate qualification criteria to ensure a broader spectrum of needs are being met through state-funded programs.

CBOs Lack Capacity to Deliver Much-Needed Resources

CBO partners shared that they don't always have the capacity needed to support and deliver these programs-long term. Investing in long-term staffing for program staff and outreach positions would help alleviate this capacity constraint.

Mobility and Medical Conditions That Compound the Impacts of Heat

Preexisting medical conditions and mobility limitations amplify one's vulnerability to heat-related illness. Homebound individuals who do not have access to cooling are at especially high risk during extreme heat events. Additionally, individuals with certain medical conditions are at higher risk for experiencing heat-related illness. Heat-related illnesses and fatalities could be mitigated through public education about effective cooling strategies and systems for identifying symptoms early.

Many Programs Are Not Well Connected

Our CBO partners shared concerns that while many programs are available to provide utility and cooling equipment assistance, they do not often work together to address residents' needs holistically. Unifying programs would increase efficiency and extend their reach to better serve communities in need.

Part IV – Research Gaps and Recommendations for Further Study

This section outlines the research gaps and recommendations for further study of issues related to cooling needs and heat vulnerability that went beyond the scope of this project.

Additional vulnerable housing types:

- Naturally occurring affordable housing – single-family or multifamily (that is not included in publicly supported housing as it is defined by Oregon Revised Statute 456.20).
- Single-family housing under multigenerational ownership in a state of disrepair.
- Tribal housing that does not fall into the categories already included in this study. Specific partnership and outreach with Tribal members is recommended to better understand their unique cooling needs and vulnerabilities.
- Evacuation housing – while included in the MLVTRG case study, a deeper dive on RVs and other wildfire evacuation housing circumstances would help increase understanding of the needs of residents who are in particularly precarious circumstances.

Agricultural workforce housing further research: There is a need for further research to understand the comprehensive needs of agricultural workers beyond those living in employer-provided housing.

Heat-vulnerable populations not included in this study:

- People experiencing homelessness.
- People renting in multifamily and single-family units that are not publicly supported.

Air quality and heat-adjacent concerns: According to a recent study, the odds of dying increase 6.1 percent on extreme temperature days and 5 percent on extreme pollution days compared with non-extreme days. On days with both extreme conditions, risk of death jumped by 21 percent.[15] Considering the context of increasing wildfires and extreme heat, further study is needed on wildfire smoke and air refuge in vulnerable housing types, combined cooling and cleaner air spaces, and heat pumps as an opportunity to address both challenges.

Power outages and peak demand: Peak demand for cooling primarily occurs during hot summer weekday afternoons. Summer heat events are likely to coincide with increasing wildfires and planned outages to reduce the risk of wildfire. Additionally, "studies have shown that for every 1°F (0.6°C) increase in summertime air temperature, the electricity demand in medium and large cities can increase by an estimated 1.5-2.0%. During extreme heat events, which are exacerbated by urban heat islands, the demand for cooling can over overload systems and result in power outages."[16] Further research is needed to determine solutions for protecting health and safety during power outages and managing electric demand.

This concludes the Oregon Cooling Needs Study. All supplemental and additional information is included in the appendices below.

Appendices

1. **Study Methodology**
    a. Oregon Cooling Needs Study Outreach and Data Collection Plan
    b. Oregon Cooling Needs Study Survey and Outreach Materials
    c. Community-Based Organization Partnerships and Contributions
    d. Outreach Outcomes and Survey Data Analysis
    e. Survey Results
    f. Financial Analysis
    g. Agricultural Workforce Housing
2. **Case Studies**
    a. McKenzie Valley Long-Term Recovery Group Residential RV Case Study
    b. Verde Heat Response Program: “Cooling Portland”
    c. Highlight of Canopy of Stories Project
3. **Geographic Information Systems Tools and Methodology**
    a. Heat Vulnerability Index
    b. HVI Results
    c. Exposure Index Results
    d. Adaptive Capacity Index Results
    e. Sensitivity Index Results
    f. Spatial Discrepancies, Limitations, and Intended Use
4. **Currently Available Financial Incentives**
5. **Endnotes**
6. **Bibliography**

1. Study Methodology

Oregon Cooling Needs Study Outreach and Data Collection Plan

The Oregon Cooling Needs Study Outreach and Data collection is provided as a separate file.

Oregon Cooling Needs Study Survey and Outreach Materials

The Oregon Cooling Needs Study outreach survey is included below. Additional outreach materials (including the following) are attached as separate files:

- Final survey in Spanish
- Types of AC units visual aid for survey (English)
- Types of AC units visual aid for survey (Spanish)
- One-page flyer (English)
- One-page flyer (Spanish)
- Social media graphic (English)
- Social media graphic (Spanish)

[Survey begins]

Oregon Cooling Needs Study Survey

Hello and thank you for your interest in participating in our survey!

This survey is part of the Oregon Cooling Needs Study being conducted on behalf of the Oregon Department of Energy (ODOE). The study is a response to the record-breaking heat wave that occurred during the summer of 2021. The heat wave and related deaths highlighted the issue of cooling access in Oregon. The study will be submitted to Oregon Legislators, who may use the information to make decisions on how to address cooling needs in the state.

The purpose of the survey is to gather information from people living in the following housing types to understand their cooling needs:

- **Publicly supported housing* (multifamily unit receiving rental assistance)**
- **Manufactured/mobile homes**
- **RVs being used as permanent dwellings**

***** In a multifamily unit, such as an apartment or condominium, within a complex or grouping of five or more units that receives rental assistance

If you live in one of these housing types, you are eligible to enter to receive a gift card for completing the survey. This survey has 20 questions and we anticipate it will take about 10-15 minutes to complete.

As a thank you for your time, we will be providing $20 gift cards to the first 750 individuals who complete the survey (if completed by June 9th, 2023). The gift cards will be sent via the email address you provide in your response by June 23rd.

By completing our survey, you will help us understand what the needs are for cooling equipment and resources in your community. Your participation in this study is completely voluntary, and you may choose to opt-out at any time. All responses will be kept confidential and data from this survey will only be reported as a collective combined total. No personal information provided will be shared or held against you.

If you agree to participate in this study, please answer the questions on the survey as best you can. Your feedback will play an important role in shaping the Cooling Needs Study and helping us identify the needs of Oregon residents.

First, we would like to know a little bit about you and your home.

1. Name
2. Email (We will be distributing gift cards to eligible participants via email. If you do not have an email address, please provide your full mailing address so we can send your gift card in the mail.)
3. Zip code
4. Do you live alone?
    a. Yes
    b. No
        i. If not, how many people live in your home, including yourself?
5. What are the age ranges of the people living in your home, including yourself? Please select all that apply.
    a. 0 – 5 years
    b. 6 – 25 years
    c. 26 – 55 years
    d. 56 – 74 years
    e. 75 years or older
6. Does anyone in your household have medical or mobility issues that prevent them from leaving your home?
    a. Yes
    b. No
7. Does anyone in your household have medical conditions that increase the risk of heat-related illness?
    a. Yes
    b. No
    c. If yes, feel free to expand:
8. Is your home:
    a. Owned by you or someone in your household?
    b. Rented?
    c. Other (please describe)
9. Which best describes your home?

a. Publicly supported housing* (multifamily unit receiving rental assistance)
b. Mobile/trailer or manufactured home
    i. Single-wide
    ii. Double-wide
    iii. Triple-wide
    iv. Modular/prefab
    v. Other (please describe)
c. Recreational Vehicle (RV)
d. Other (please describe) - ***Please note that if your housing type is not one of the three that are being focused on for this study, you may not be eligible to receive a gift card for your participation in this survey.***

***** *In a multifamily unit, such as an apartment or condominium, within a complex or grouping of five or more units that receives rental assistance*

In this section, we would like to learn about your experience managing the heat and staying cool on hot days within your home.

10. Which cooling/air conditioning systems are in your home? Which of these systems works in your home? **Please select all that apply.**

    Click here for photo examples of cooling systems listed below

    a. No cooling system/none of these
    b. Central air conditioner
    c. Central heat pump
    d. Ductless heat pump, also known as "mini-split"
    e. Window or wall air conditioner
    f. Portable air conditioner
    g. Evaporation or swamp cooler
    h. Sunshades/sunscreens/blinds
    i. Electric fans (ceiling or portable)
11. Other than cooling equipment, how does your household stay cool/comfortable on hot days? **Please check all that apply.**
    a. On-site, communally shared cooling space
    b. Going to an air-conditioned indoor public place (e.g., library, mall, off-site cooling centers)
    c. Going to a friend or family member's house
    d. Going outdoors (trees/shade, going to a park, sprinkler, kid pools)
    e. Cold showers or baths
    f. Public pools/swimming
    g. Cold food/drink (popsicles, ice water, etc.)

h. Opening and closing windows based on outdoor temperature
i. Limiting the use of heat-producing appliances/electronics
j. Other (please describe) _____

12. If you have cooling system(s) in your home, does anything limit you from using your cooling system when you are hot?
    a. N/A (no cooling system(s) in your home)
    b. No
    c. Yes
        i. If yes, what? **(Please check all that apply)**
            1. Cost of (utility) bills
            2. Cost of repairs
            3. Medical and/or mobility limitations
            4. Confusing technology
            5. Electrical issues/limitations (e.g., electricity does not support AC or causes frequent outages)
            6. Does not work
            7. Other _____
        ii. During the past summer, about how often was your household without cooling/air conditioning due to the above reasons?
            1. Often
            2. Sometimes
            3. Rarely
            4. Never
13. At what <u>outside</u> temperature do you start to feel too hot inside your home?
    a. Below 70 degrees Fahrenheit | 20 degrees Celsius
    b. 71-80 degrees Fahrenheit | 21-26 degrees Celsius
    c. 81-90 degrees Fahrenheit | 27-32 degrees Celsius
    d. 90-100 degrees Fahrenheit | 33-37 degrees Celsius
    e. Above 100 degrees Fahrenheit | 38 degrees Celsius
14. Has anyone in your household needed medical attention because your home was too hot?
    a. Yes
    b. No
    c. Maybe/unsure _____
15. Please indicate how much you agree or disagree with the statements below:
    a. My home is drafty, and/or feels uncomfortable on very hot or very cold days
    b. I pay close attention to the cost of my energy bills every month
    c. I worry whether there is enough money to pay my energy/utility bill
    d. I worry about a major appliance (like my furnace, A/C, or refrigerator) breaking down

e. When something in my home needs to be fixed, I am more likely to fix it myself rather than hire a contractor or professional

16. Are you aware of the following community programs or services to help you with:
    a. The cost of utility bills?
        i. No
        ii. Yes, but never used the service
        iii. Yes, I have used the service
    b. Cooling system or weatherization repairs?
        i. No
        ii. Yes, but never used the service
        iii. Yes, I have used the service
    c. Emergency cooling centers you can visit to prevent overheating during hot days.
        i. No
        ii. Yes, but never used the service
        iii. Yes, I have used the service

17. If you have not used any utility assistance, community programs or services, please select your reason(s). Please select all that apply.

    Further information about Oregon as a sanctuary state.

    a. Unaware of program(s)
    b. Don't qualify
    c. Don't know if I qualify
    d. Don't have contact information
    e. Concerns around citizen/immigration status *(Note: Oregon is a sanctuary state and any information provided will remain anonymous and will not be reported or used against you)*
    f. Difficult hearing/filling out application on the phone
    g. Difficulty seeing/reading materials
    h. Language barriers
    i. Apprehension in working with government
    j. Complicated process
    k. Not interested in the program(s)
    l. Other (please list)
        i. If one of your responses above was "Other" please describe.

18. Are you interested in improving the cooling systems in your home?
    a. Yes
    b. No

19. If so, what type of support would you need to move forward with a project? (Check all that apply)
    a. Help with initial costs (e.g., cash advance or loan, free equipment)

b. Help with ongoing costs or energy/utility bills
c. Technical support (e.g., choosing the right equipment or installation)
d. Maintenance or repairs of new or existing equipment
e. Administrative support (filling out forms)
f. Other (please describe)

20. Please share any other kinds of help you would need to access energy assistance or upgrade programs.

This concludes the Oregon Cooling Needs Study Survey. Please check this box if you would like to be entered to receive a $20 gift card. We will be distributing gift cards to the first 750 eligible people who complete the survey. Gift cards will be sent via email or mail to the address you provided at the beginning of the survey.

If you are willing, we would like to collect additional demographic information to better understand the populations we are serving. The following questions are optional.

A. What ethnicities are represented in your household? Please check all that apply
   a. Black and African American
   b. Native American and Alaska Native
   c. Native Hawaiian
   d. Asian
   e. Pacific Islander
   f. Middle Eastern and North African
   g. White
   h. Latinx/a/o, Hispanic
   i. Latinx/a/o, Indigenous Descent
   j. Prefer not to Answer

B. What is your annual household income?
   a. Less than $25,000
   b. $25,000 - $50,000
   c. $50,000 - $100,000
   d. Other
   e. Prefer not to answer

C. What is your preferred language?

Thank you for your time and participation in the Oregon Cooling Needs Study! If you have any questions or need the survey to be provided in an alternative format or language, please contact us via email (SGodber@parametrix.com) or the comment box below.

[End of survey]

Community-Based Organization Partnerships and Contributions

Special acknowledgement is warranted for the community-based organization (CBO) partners who serve as trusted community ambassadors and advisors on the outreach and community-sourced data collection for this study. The CBO partners assisted in determining the best outreach methods to reach the residents and communities they serve and provided essential capacity to distribute the survey statewide.

Each partner brought a unique perspective to the project and access to different communities through their existing relationships and on the groundwork in the communities they serve. This study would not have been possible without their partnership and support.

Community in Action: CinA conducted direct, over-the-phone surveys with clients they serve in Malheur and Harney counties. They also engaged in a follow-up interview after outreach was completed to provide qualitative information regarding their experience delivering services to the communities they serve.

Homes for Good: Homes for Good promoted the survey through direct outreach to clients in their weatherization program and posted flyers and survey promotional materials at their network of multifamily properties.

Lake County Resources Initiative: LCRI provided direct, over-the-phone surveys and online outreach to their networks in Lake and Klamath Counties, and in person outreach while conducting home energy assessments. They also engaged in a follow-up interview after outreach was completed to provide qualitative information regarding their experience delivering services to the communities they serve.

McKenzie Valley Long-Term Recovery Group: MVLTRG distributed surveys directly to households living in manufactured/mobile homes and recreational vehicles in the McKenzie Valley, dropped off promotional materials at frequented community gathering places, personally emailed households in their network, mailed surveys to individuals that they did not have emails for, and shared the survey on social media and via their newsletter. Additionally, MVLTRG provided key insights into the case study on RV's being used as semi-permanent housing for wildfire recovery. Their knowledge and lived experience with this circumstance and the associated barriers, opportunities, resources needed, and equipment types provided imperative anecdotal evidence for this study.

Oregon Rural Action: Oregon Rural Action distributed the survey via direct, door-to-door outreach at multifamily properties in Umatilla County, including providing live translation services to Spanish speaking participants. They also engaged in a follow-up interview after outreach was completed to provide qualitative information regarding their experience delivering services to the communities they serve.

Pineros Y Campesinos Unidos del Noroeste: PCUN distributed the survey via direct, door-to-door outreach in Marion County with a focus on framework and agricultural communities living

the housing types included in this study. PCUN also provided live translation services for Spanish speaking participants. They also engaged in a follow-up interview after outreach was completed to provide qualitative information regarding their experience delivering services to the communities they serve.

Unete: Unete distributed the survey via direct, door-to-door outreach, over-the-phone outreach, and via their classes and community events in Jackson and Josephine Counties. Unete also provided live translation services for Spanish speaking participants. They also engaged in a follow-up interview after outreach was completed to provide qualitative information regarding their experiences delivering services to the communities they serve and feedback about the survey structure and Spanish translation.

Outreach Outcomes and Survey Data Analysis

Outreach Outcomes

The consulting team established partnership with eight CBO's and three local utilities within the priority counties and communities to assist with survey outreach and distribution. Outreach partners included:

- Verde
- Community in Action
- Homes for Good
- Lake County Resources Initiative
- McKenzie Valley Long-Term Recovery Group
- Oregon Rural Action
- Pineros Y Campesinos Unidos del Noroeste
- Unete
- Eugene Water & Electric Board
- Portland General Electric
- Umatilla Electric Cooperative

Survey materials were developed and reviewed alongside Verde and ODOE. The survey was posted online within an ArcGIS StoryMap in English and Spanish. The StoryMap provided additional information about the project, outreach partners, and available resources.

Outreach efforts included email distribution, social media posts, door-to-door outreach, phone outreach, and flyer distribution in neighborhoods and at events. CBOs conducting outreach in person distributed physical gift card incentives and had predetermined outreach goals to ensure equitable distribution of incentives, budget, and responses among the priority counties. All partners were supplied with links to the online survey platform and printable versions of the survey and outreach materials in English and Spanish.

The survey was open to the public May 31, 2023, until June 12, 2023. Results were collected online, on paper in person, and over the phone. Paper responses were inputted into the survey platform by CBO partners and the consulting team.

Survey outcomes are measured based on the success metrics defined in the outreach plan, as follows:

- Total number of responses: 948
- Number of responses by housing type
    - Publicly supported housing: 410
    - Mobile/manufactured homes: 406
    - Recreational vehicles used as housing: 132
- Number of responses from priority counties
    - Clackamas County: 81
    - Deschutes County: 10
    - Douglas County: 8
    - Jackson County: 161
    - Josephine County: 25
    - Klamath County: 18
    - Malheur County: 37
    - Marion County: 153
    - Multnomah County: 97
    - Umatilla County: 36
    - Wasco County: 23
    - Washington County: 72
- Number of responses from target population(s) including:
    - Older adults:
        - Age 55 to 74: 40 percent of survey respondents have someone in this age range in their household
        - Age 75 and older: 11 percent of survey respondents have someone in this age range in their household
    - People living alone: 227
    - Low-income individuals: 668 respondents indicated having an annual household income less than $50,000, and 208 respondents indicated being in the $50,000 to $100,000 bracket.
    - People with health concerns: 350 respondents indicated that they have medical issues that increase the risk of heat-related illness.
    - Those who are homebound: 270 respondents indicated that someone in their household has medical or mobility issues that prevent them from leaving their home.
    - Hispanic/Latino and BIPOC communities: 579

- People living in areas of the state that are most susceptible to extreme heat: 721

Survey Data Analysis

The online survey initially generated over 10,000 bot responses. The following methods were used to identify and filter out invalid responses.

- Removed invalid zip codes (outside of Oregon)
- Removed responses with inconsistent answers (e.g., marked home as owned, but they live in a publicly assisted apartment)
- Removed non-names, first names only, and responses with clearly false email addresses (e.g., qqqqqnnnnnnnddddddddkwyoqerjkf@gmail.com)
- Removed responses with Latin or Chinese character responses to open-ended questions
- Removed responses from midnight to 4 a.m. and multiple entries with similar responses within the same one-hour time window
- Removed responses where email and name did not match: (e.g., name spelled J**aim**e Odin**son**; email entered is j**ami**eodin**sin**@gmail)
- Removed duplicate responses to open-ended questions, particularly looking at question 20
- Removed responses with inconsistencies in written open-ended responses and responses to other questions
- Removed responses that checked having all forms of air conditioning (all permanent and all temporary) or four or more of the permanent and temporary

Based on this methodology, total responses were pared down to 948 total remaining responses. Results from the door-to-door/in-person outreach administered by our CBO partners were collected separately on a password-protected platform and later aggregated with the authenticated results from the public online survey.

Survey Results

1. **Do you live alone?** Yes: 227, No: 720, No Response: 1
2. **What are the age ranges of the people living in your home, including yourself?**
   Percent of respondents indicating residents with age ranges:

0 – 5	6 – 25	26 – 55	56 – 74	75 and up
23%	63%	55%	40%	11%

3. **Does anyone in your household have medical or mobility issues that prevent them from leaving your home?** Yes: 207, No: 734, No Response: 7
4. **Does anyone in your household have medical conditions that increase the risk of heat-related illness?** Yes: 350, No: 595, No Response: 3
5. **Is your home: Owned by you or someone in your household? Rented? Other (please describe)**

Housing Type	Owned	Rented	Grand Total
Mobile/trailer or manufactured home	268	122	390
Publicly supported housing	3* *Verified responses may be a misunderstanding of the question*	399	402
RV being used as a permanent dwelling	86	36	122

6. Which best describes your home?

- **a. Publicly supported housing* (multifamily unit receiving rental assistance)** 410
- **b. Mobile/trailer or manufactured home** 406
  - **i. Single-wide** 141
  - **ii. Double-wide** 196
  - **iii. Triple-wide** 48
  - **iv. Modular/prefab** 17
  - **v. Other (please describe)**
- **c. Recreational Vehicle (RV)** 132
- **d. Other (please describe)**

7. Which cooling/air conditioning systems are in your home?

Housing Type	Central AC	Central Heat Pump	DHP	Window or Wall AC	Portable AC	Swamp Cooler	Blinds	Electric Fans	No Cooling	Other
Manufactured /Mobile	136	79	40	130	73	22	86	150	30	1
Multifamily	104	36	26	163	114	24	97	193	25	2
Residential RV	45	14	8	44	43	16	52	58	9	7
Survey Total	285	129	74	337	230	62	235	401	64	10

8. Which of these systems works in your home?

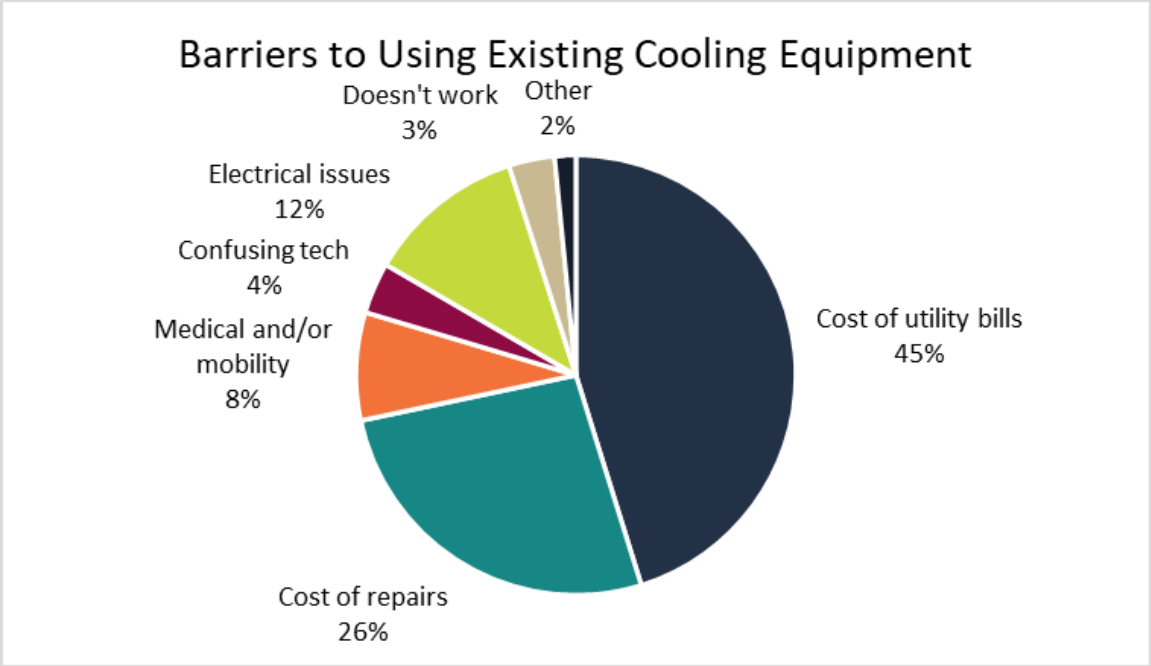
Housing Type	Central AC	Central Heat Pump	DHP	Window or Wall AC	Portable AC	Swamp Cooler	Blinds	Electric Fans	No Cooling	Other
Manufactured /Mobile	130	66	42	118	67	16	86	140	28	1
Multifamily	101	30	25	151	98	20	90	188	24	4
Residential RV	38	12	5	38	40	15	44	52	13	8
Survey Total	269	108	72	307	205	51	220	380	65	13

9. Other than cooling equipment, how does your household stay cool/comfortable on hot days?

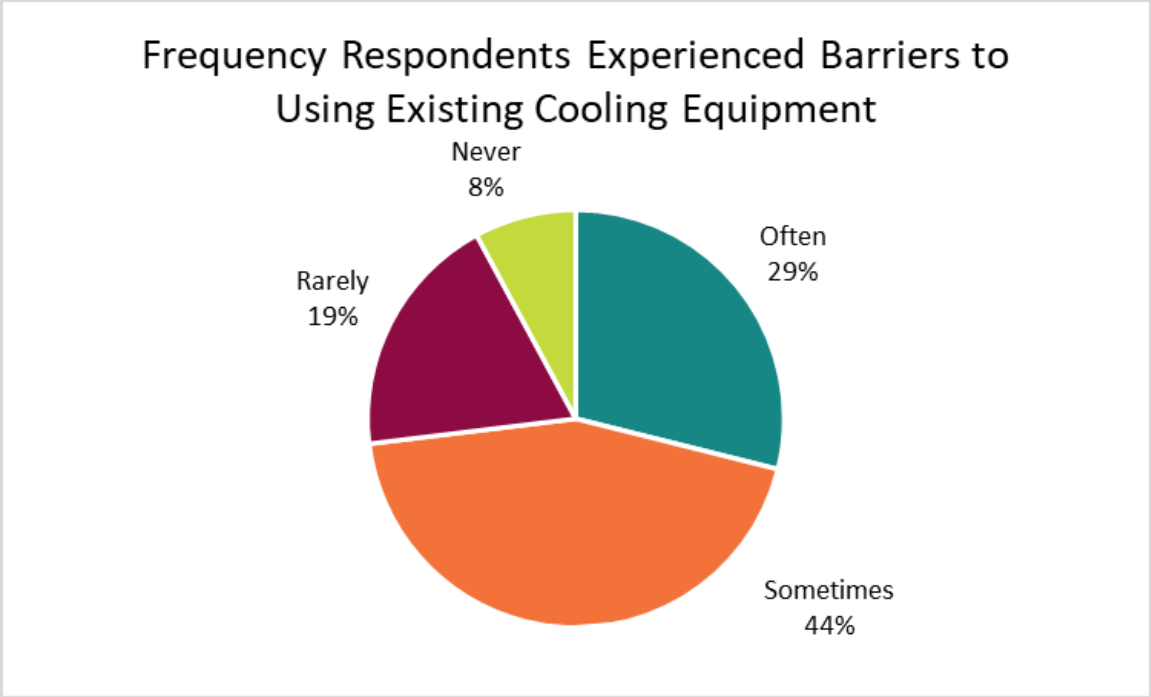
Housing Type	On-Site Cooling Space	AC Indoor Public Place	Friend or Family	Outdoors	Cold Showers	Public Pools	Cold Food/Drink	Opening/Closing Windows	Limiting Heat-Producing Appliances	Other
Manufactured/ Mobile	40	120	73	210	171	115	178	200	133	13
Multifamily	38	116	66	209	226	135	223	233	103	21
Residential RV	36	35	32	83	66	52	65	77	53	8
Survey Total	114	271	171	502	463	302	466	510	289	42

10. If you have cooling system(s) in your home, does anything limit you from using your cooling system when you are hot?

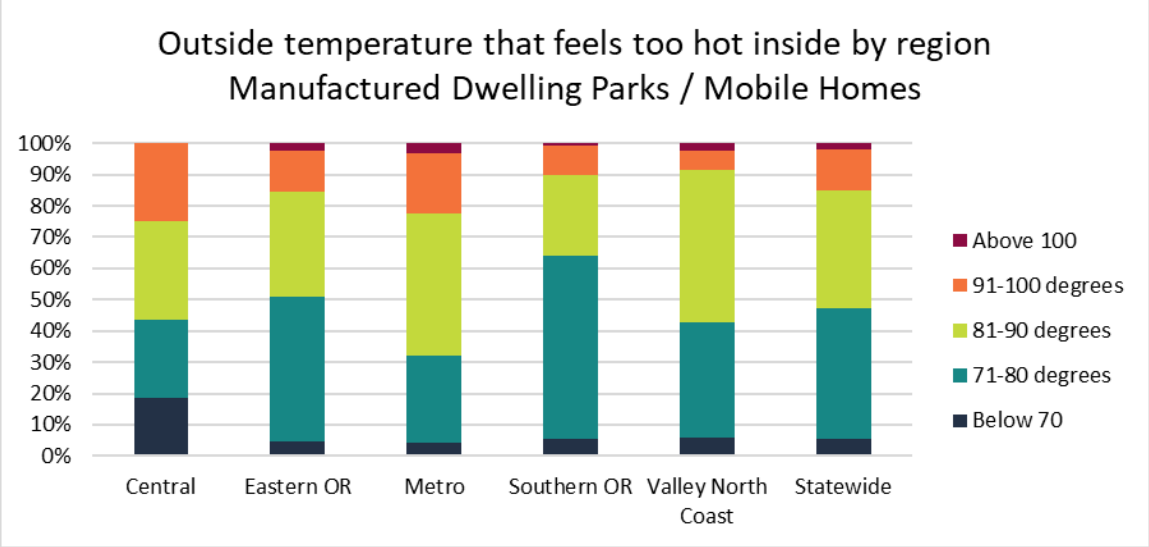
a. If yes, what?

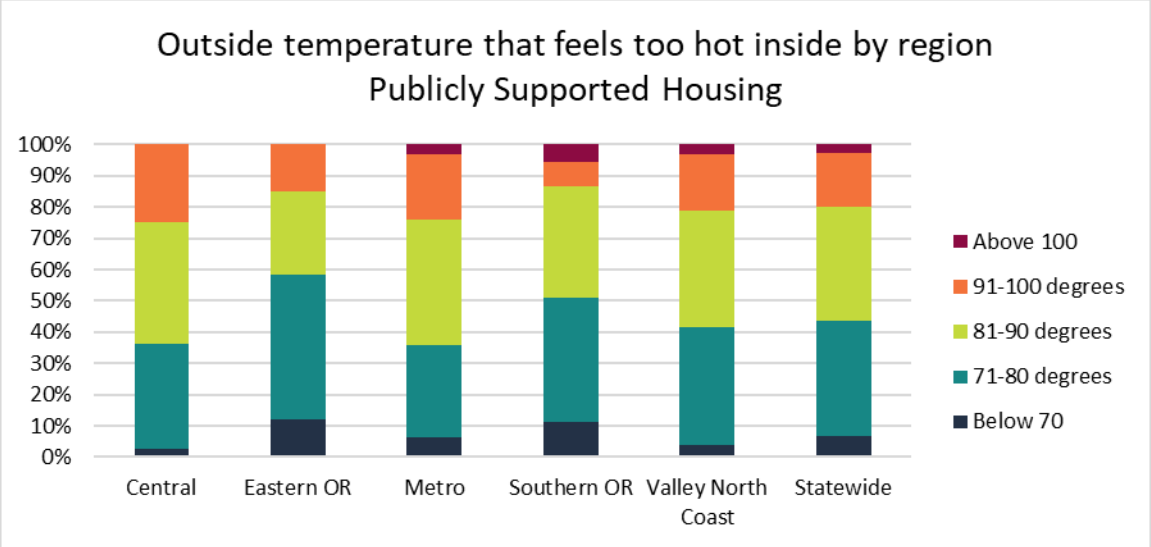


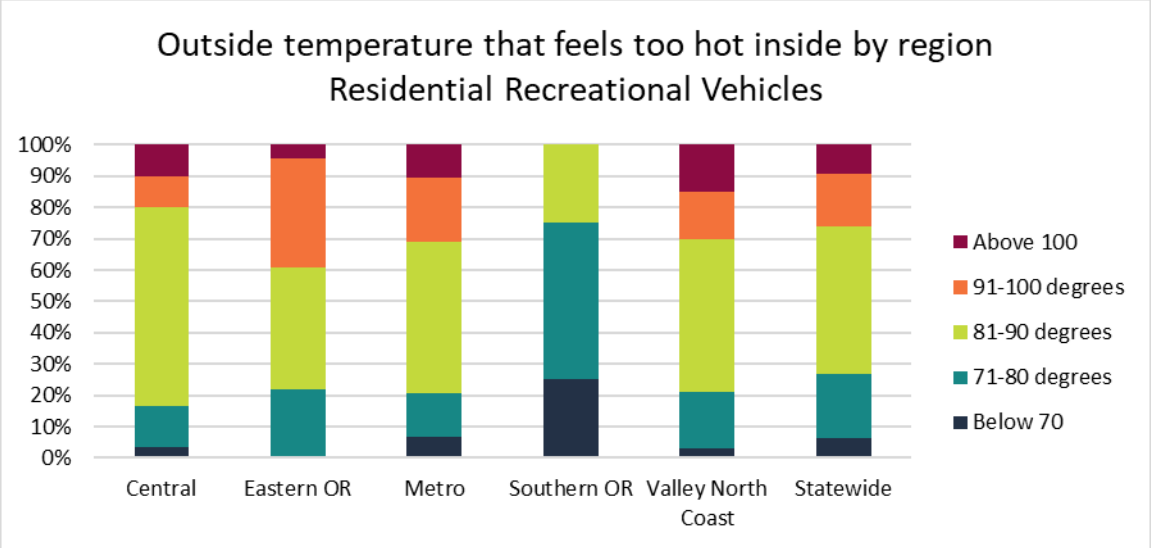
b. During the past summer, about how often was your household without cooling/air conditioning due to the above reasons?



11. At what <u>outside</u> temperature do you start to feel too hot inside your home?





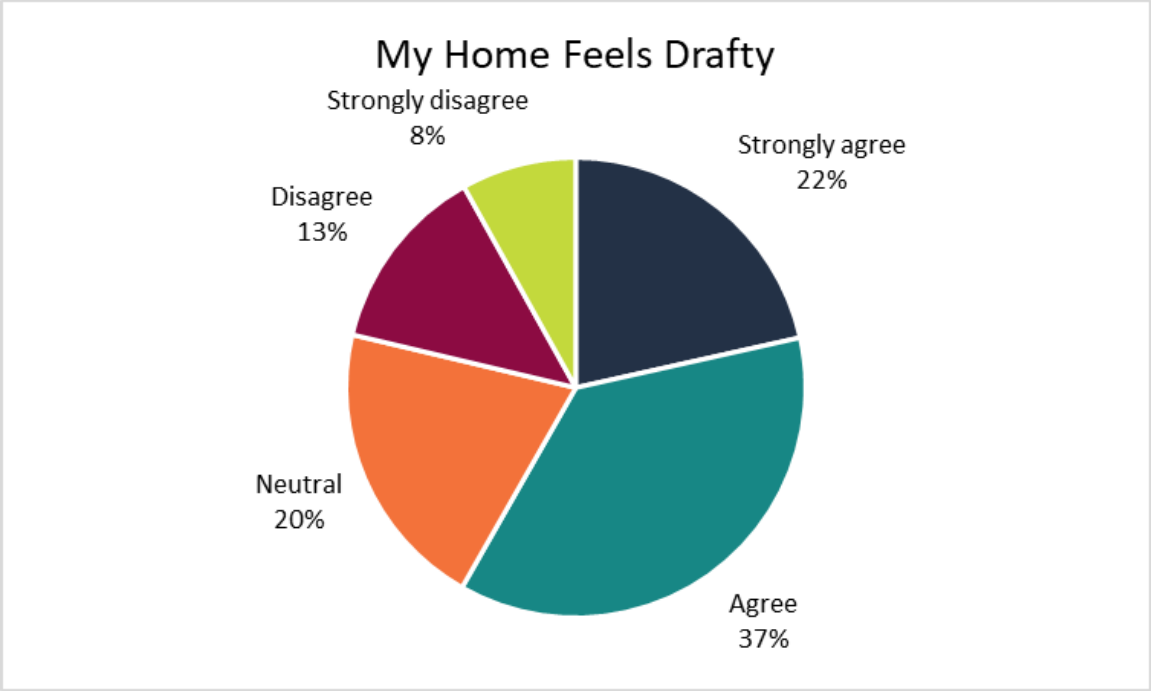


12. Has anyone in your household needed medical attention because your home was too hot?

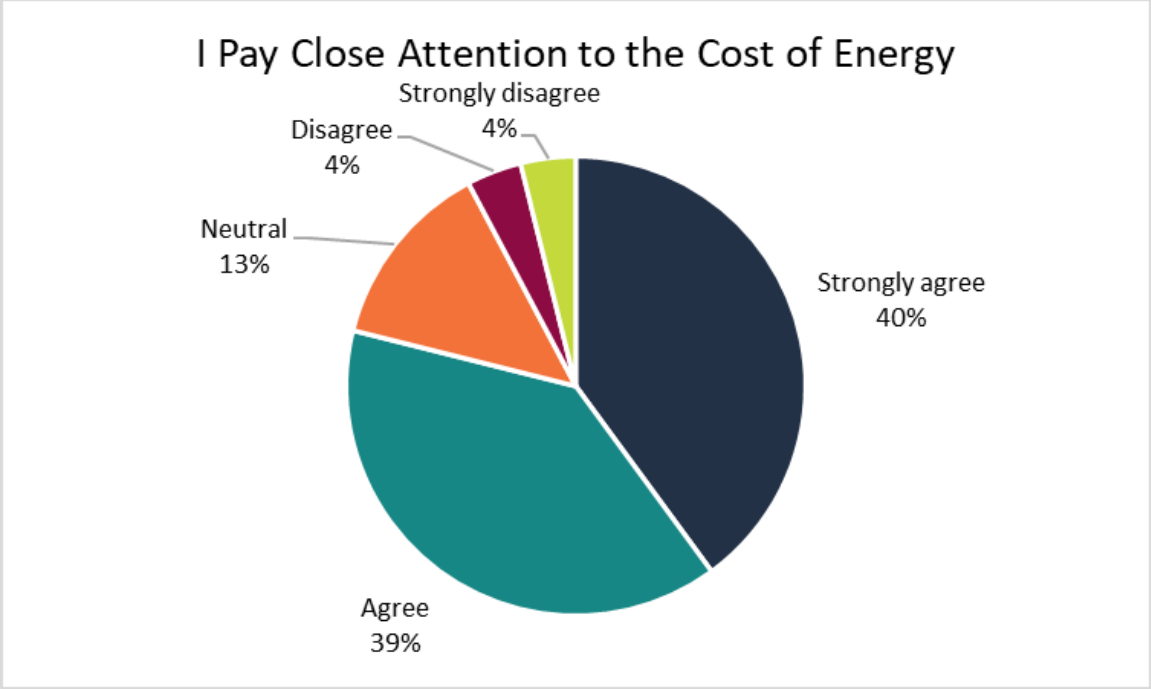
Housing Type	Yes	No	Maybe/Unsure
Manufactured/Mobile	94	304	4
Multifamily	111	293	4
Residential RV	43	84	4
Survey Total	248	681	12

13. Please indicate how much you agree or disagree with the statements below:

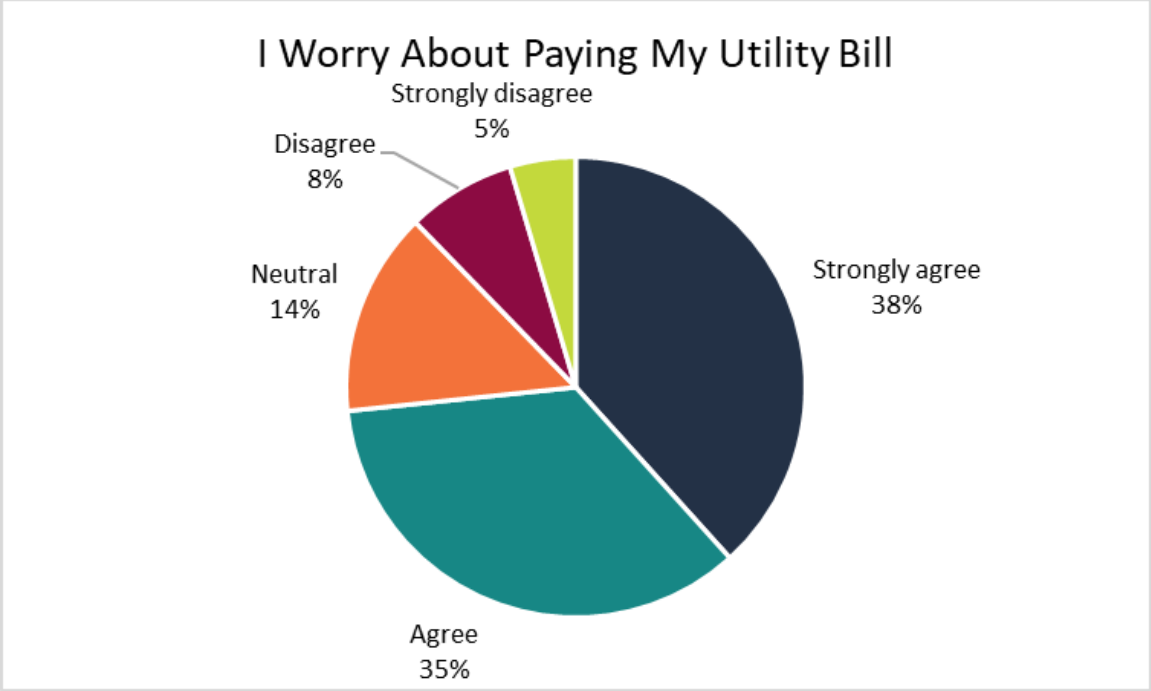
a. My home is drafty, and/or feels uncomfortable on very hot or very cold days



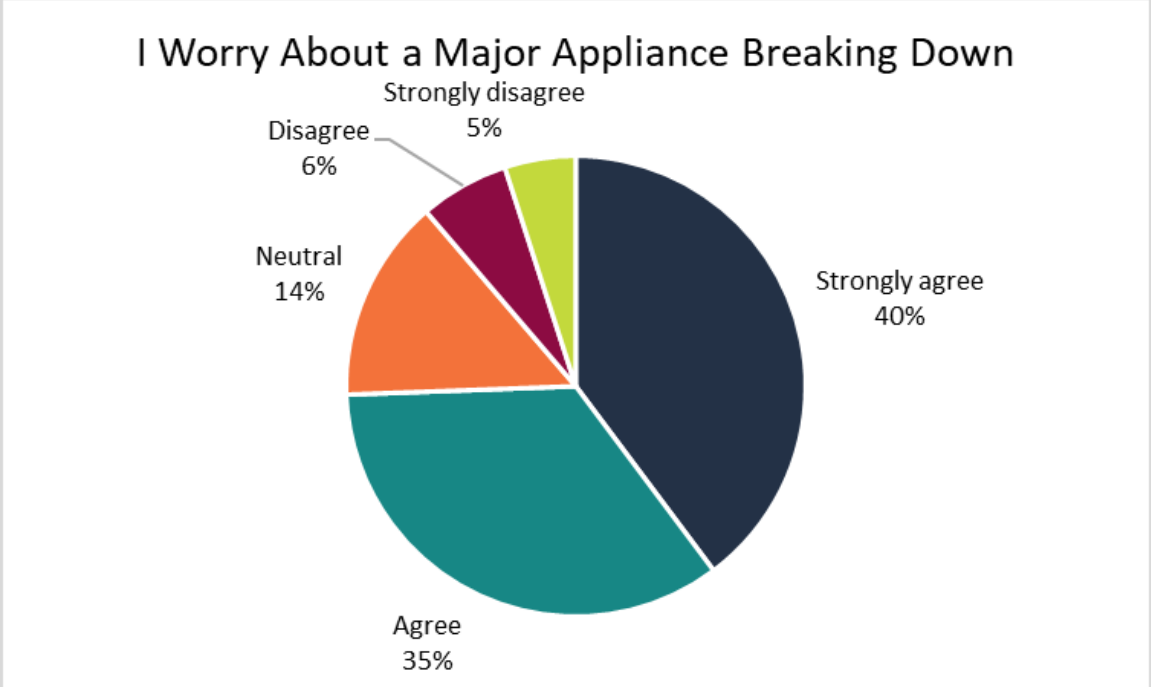
b. I pay close attention to the cost of my energy bills every month



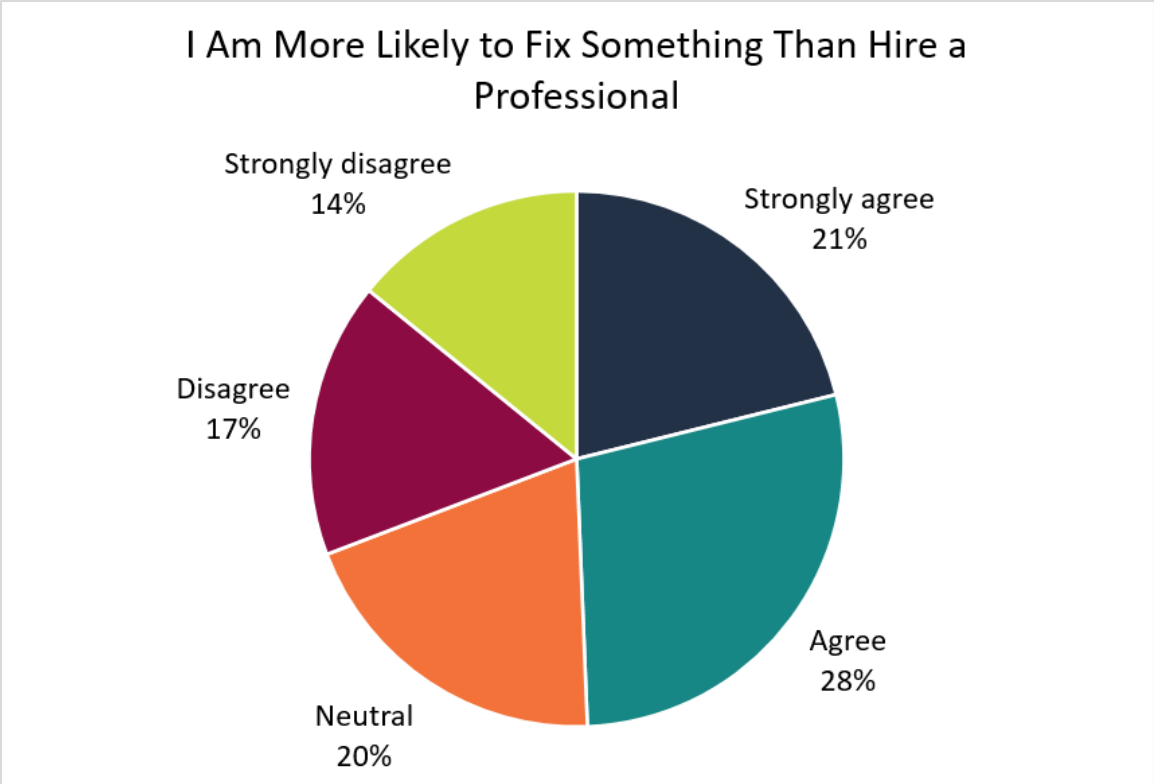
c. I worry whether there is enough money to pay my energy/utility bill



d. I worry about a major appliance (like my furnace, A/C, or refrigerator) breaking down



e. When something in my home needs to be fixed, I am more likely to fix something than hire a professional



14. Are you aware of the following community programs or services to help you with:

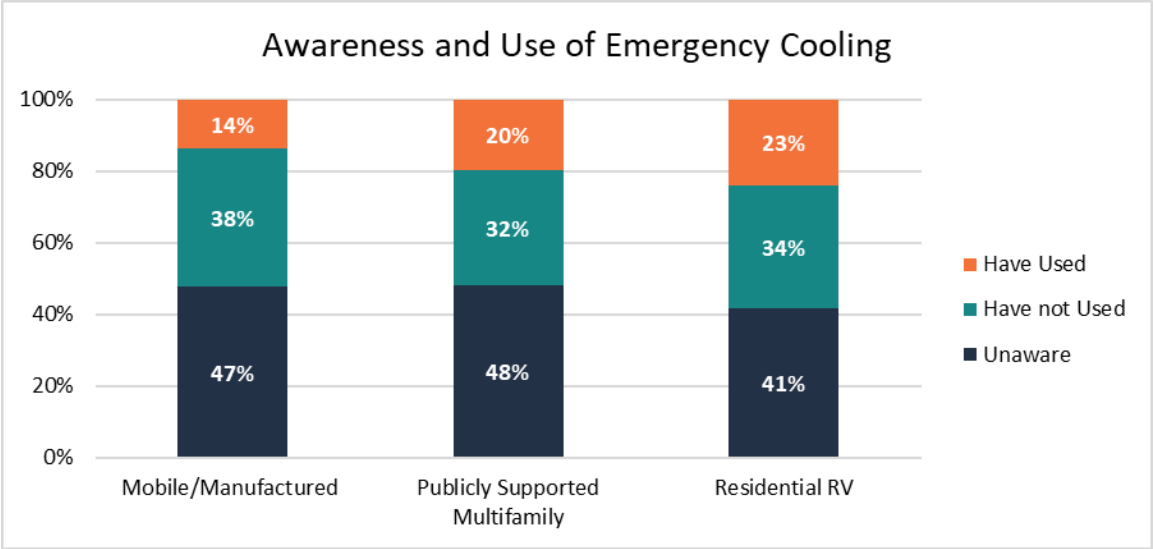
a. The cost of utility bills?

Housing Type	No	Yes – have not used	Yes – have used
Manufactured/Mobile	161	129	114
Multifamily	157	106	145
Residential RV	41	49	39
Survey Total	359	284	298

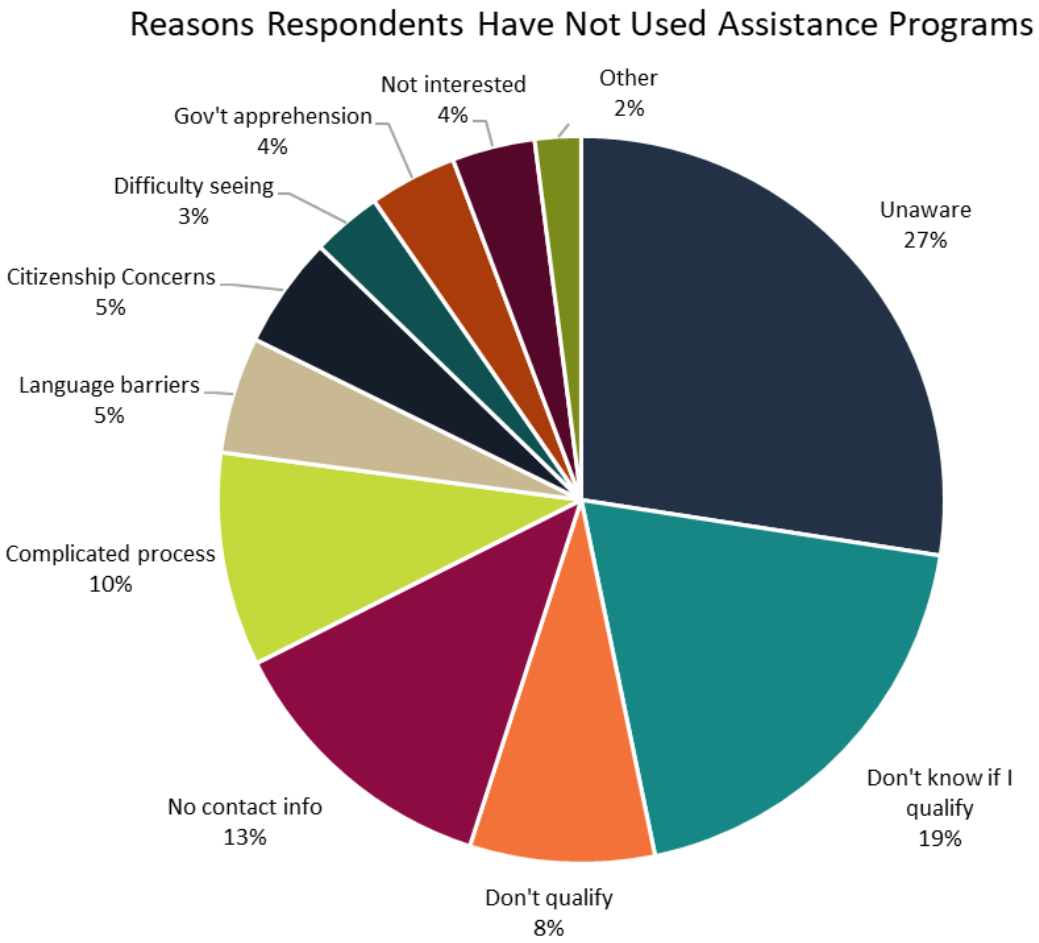
b. Cooling system or weatherization repairs?

Housing Type	No	Yes – have not used	Yes – have used
Manufactured/Mobile	214	115	67
Multifamily	236	99	68
Residential RV	61	41	27
Survey Total	511	255	162

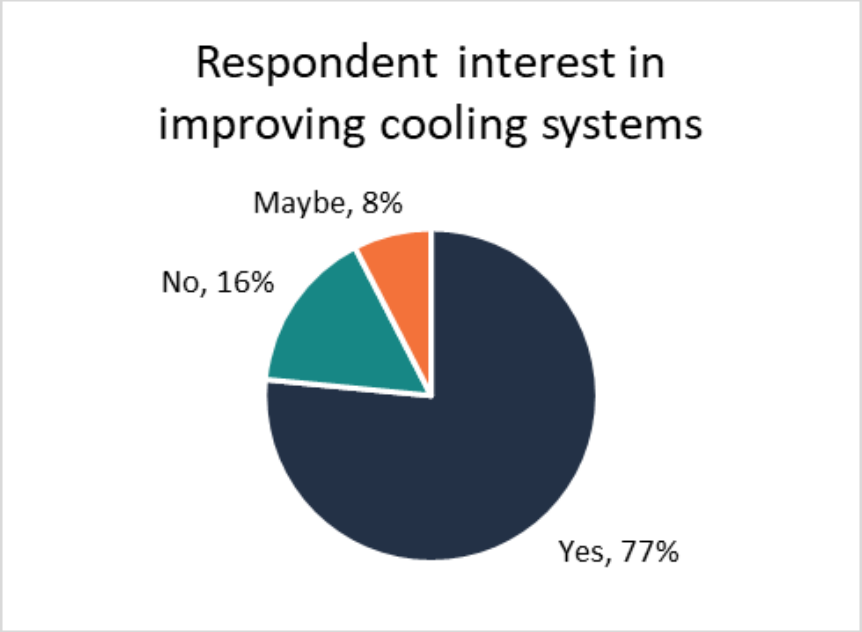
c. Emergency cooling centers you can visit to prevent overheating during hot days.



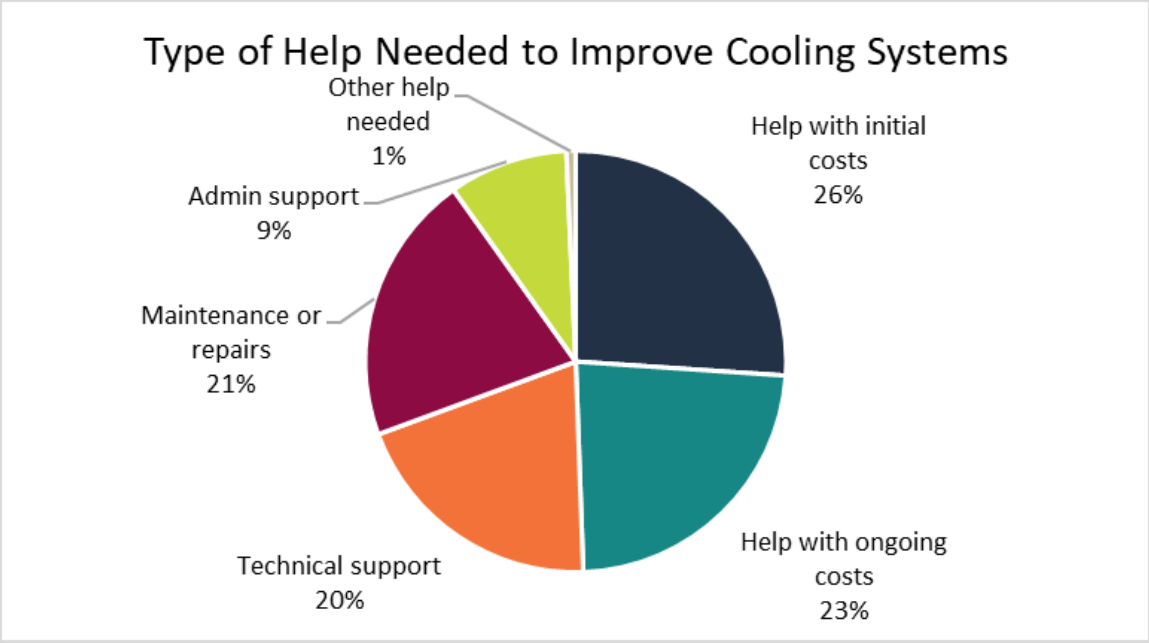
15. If you have not used any utility assistance, community programs or services, please select your reason(s).



16. Are you interested in improving the cooling systems in your home?



17. If so, what type of support would you need to move forward with a project?



18. Please share any other kinds of help you would need to access energy assistance or upgrade programs. Open-ended responses

A. What ethnicities are represented in your household? Please check all that apply

Asian	14
Black	199

Latino Hispanic	260
Latino/a Indigenous	5
Middle Eastern	8
Multi-Racial	62
Native American	21
Pacific	10
White	334
No Response	35

B. What is your annual household income?

Less than $25,000	372
$25,000 – $50,000	296
$50,000 – $100,000	208
Other	16
Prefer not to answer	56

C. What is your preferred language?

Arabic or English	1
English	641
English/Samoan	3
English/Spanish	8
Spanish	203
Spanish/Indigenous	6
Mandarin	1
Mixteco	2
Ukrainian	1
No Response	82

Financial Analysis

To calculate the cost to meet the statewide cooling needs, the consulting team created two scenarios that illustrate a range of cost. The scenarios are defined below.

Financial Analysis Assumptions

Cost Categories	Comprehensive Cooling Scenario	Health and Safety Baseline Scenario
Cooling Equipment	**M, P:** 1 zone per bedroom + 1 for common spaces ductless heat pump **A:** 3-zone ductless heat pump system per unit **R**: 1 RV central AC per housing unit	**M, P:** 1 zone for common spaces ductless heat pump **A:** 1-zone ductless heat pump system per unit **R**: 1 portable (50%) *or* 1 window (50%) AC per housing unit
Panel Upgrades	**M, P:** $3,000 for pre-1980 units **A:** $3,000 for all units	**M, P:** $3,000 for pre-1980 units **A:** $3,000 for all units
Minor Home Repairs	$500 for 50% of units	$500 for 25% of units
Minor Envelope Upgrades	$1,000 for 50% of units	$1,000 for 25% of units
Travel to Remote Counties	**M, P, R:** $500 for all counties except Clackamas, Lane, Marion, Multnomah, Washington **A:** $500 for all units	
Agricultural Workforce Housing Unit Size	**A:** average of 7 occupants per unit	
Housing Types Identifiers: ***M**: Manufactured/Mobile, **P**: Publicly Supported, **R**: Recreational RV, **A**: Agricultural Workforce Housing*		

Ductless Heat Pump Cost[x]

Number of Zones	Average cost
1	$7,349
2	$12,160
3	$14,310
4	$18,979
5	$27,502

Agricultural Workforce Housing

Residents living in agricultural workforce housing were not directly surveyed for this study for the following reasons:

1. Farmworker housing was added as an amendment to the study after initial surveying was complete and past the prime agricultural season in Oregon, resulting in limited capacity and lack of feasibility to conduct direct on-the-ground outreach.
2. A current rulemaking process was underway that was expected to change the requirements and landscape of cooling in agricultural workforce housing.

Due to these factors, the agricultural workforce housing findings are informed by research and interviews rather than direct outreach and included separately from the findings for the rest of the housing types.

Organizations and entities consulted with for this section of the study included:

- Comunidades
- Oregon Agricultural Labor Housing Task Force
- Oregon Agricultural Workforce Housing Facilitation Team
- Oregon Department of Consumer and Business Services/ Occupational Safety and Health
- Oregon Department of Housing and Community Services
- Pineros y Campesinos Unidos del Noroeste

[x] Costs modeled from information on Carbon Switch used average cost by zone and adjusted to the cost per square foot for the West region. Learn more at https://carbonswitch.com/mini-split-installation-cost/

2. Case Studies

McKenzie Valley Long-Term Recovery Group Residential RV Case Study

MVLTRG is a nonprofit organization dedicated to providing services to the communities in McKenzie Valley who were impacted by the 2020 Holiday Farm Fire, which destroyed an estimated 517 homes. Many RVs were purchased directly by the individuals through their insurance or were provided as temporary housing to residents who lost their homes by Oregon Housing and Community Services under the Wildfire Recovery and Resilience Account. Currently, 80 to 90 permitted RVs are used as semipermanent wildfire recovery housing in the McKenzie Valley. While these RVs are intended to be a temporary solution while rebuilding takes places, it is estimated that some families will not be permanently housed for up to 10 years after the fire took place, due to limitations and lengthy processes tied to funding, land use restrictions, and lengthy contract and construction periods. The following anecdotal information was provided by MVLTRG based on their experience working directly with residents recovering from the Holiday Farm Fire and provides important context for identifying the cooling needs for this housing type statewide.

RVs are not designed or suitable for long-term, permanent use as housing

This sentiment was echoed by several community-based organization (CBO) partners serving residents living in RVs statewide.

- RVs lack sufficient insulation, cost more to cool and heat, and are subject to higher maintenance needs.
- MVLTRG staff are seeing many RV systems breaking down after the third year of being used for full-time living.

Cooling Equipment in Residential RVs

- The majority of RVs in the McKenzie Valley were built equipped with permanent AC units, but most of these units were already or have since become nonfunctional and in need of repair. Built-in RV AC units are designed to last three to 10 years, based on normal usage of RVs as recreational vehicles, but when RVs are used full-time as housing, this lifespan is shortened to one to two years.
- Portable, temporary AC units have been provided by MVLTRG to residents to address this need, but these units pose their own unique challenges. Temporary AC units have to be drained, which is difficult for older or mobility-limited residents to do. When neglected, water may overflow into the RVs, which may lead to other damages.
- Because RVs are not well insulated, it is challenging for residents to maintain comfortable temperatures. This also leads to higher energy costs for those who do have cooling equipment. MVLTRG has provided inflatable insulation for the underpinnings of RVs to help address this issue and alleviate the inefficiencies for heating and cooling.

However, this method of insulation was found to be cumbersome and challenging to use, blocking essential undercarriage storage for residents.

Suggested Solutions to Meet Cooling Needs

MVLTRG's recommendation for meeting the cooling needs of residents living in RVs is to prioritize maintenance and repairs of existing AC equipment.

- MVLTRG's experience has shown that the cost to meeting residents' cooling needs is approximately $1,700 to $4,000 per unit and is anticipated to be needed on a recurring basis every few years. While MVLTRG has also provided temporary portable units to residents, they have found that these often cause issues with water leakage, so additional education on operation and use is needed if used.
- Although fixing existing AC systems is a costly solution, MVLTRG suggests it is the best way to meet the needs of residents living in RVs. The organization has found that community members feel safest in their homes during extreme weather events and generally do not use off-site cooling shelters during heat events.

RV parks are also subjected to frequent power outages, especially as planned utility shutoffs become more common as a method for mitigating wildfire risk (especially in rural areas), and many residents must rely on propane to power generators for power in these instances.

- During wildfire season, cooling and air filtration are compounding needs alongside the risk of evacuations.
- To help address the issue of utility shutoffs and power outages, MVLTRG provides propane vouchers for residents as a backup energy source for powering generators, which has proven to be a meaningful way to assist with energy costs and emergency preparedness.
- Propane is much more expensive than electricity and is not ideal for individuals who are elderly or have mobility issues due to being difficult to handle, but it is a necessary form of energy during outages and extreme weather events.
- MVLTRG also identified the need for generators for all housing types in the community considering the reality of increasingly frequent power outages. This issue is pertinent across many rural communities in Oregon, especially those with the highest risk of wildfire. MVLTRG has found whole house generators installed with propane tanks to cost $15,000 to $17,000 for a moderate sized home.

Additional Considerations of Transitioning these Communities to Permanent Housing

MVLTRG have found RVs being used as long-term housing to be substandard and costly. Another CBO partner shared that in terms of wildfire recovery, "RVs are not a solution, they are a continuation of the problem."

- While readily available and lower capital cost option for wildfire recovery communities, RVs are burdensome for the residents living in them and do not provide any opportunities for community members to build wealth through investing in their homes.
- The goal is to transition residents to permanent housing as quickly as possible. However, barriers to rebuilding have slowed the process for many Oregonians.
    - Between insurance and funding challenges to decisions and restrictions around rebuilding, permitting, contracting, and construction, total recovery time for the entire community to be permanently housed is estimated to take up to 10 years.
    - In the McKenzie Valley, RVs are permitted under a special permit until 2025, but it is likely this will need to be reconsidered if the recovery process continues at the current pace.

It is also important to note that current land use regulations that limit density in urban areas and restrict the allowable housing types in rural areas limit the opportunities for communities to adapt and build/rebuild more quickly to suit individual needs.

- Building code and manufactured home park regulations also limit the options for rebuilding different types of affordable, energy efficient units.
- While this issue goes beyond the scope of this study, it is tied to the overall housing shortage in Oregon and prevalence of RVs and other substandard housing types being used as permanent dwellings and wildfire recovery options.
- MVLTRG suggested that alternatives such as tiny homes or modular homes could provide more energy efficient, lower cost, and higher standards of living if they were permittable and readily available.
    - However, there have also been recent challenges with a batch of about 60 modular homes intended for wildfire recovery that were not built to code/standard and found to be substandard/uninhabitable. Replacing these homes is estimated to cost $20 to $25 million (~$330,000 to $415,000 per unit) and take another year or longer.[17]

With all this in mind, RVs continue to be a widely used option to provide immediate relief in challenging circumstances.

Verde Heat Response Program: "Cooling Portland"

Verde, a key partner for this project, provided the following case study and a corresponding presentation for ODOE staff and the consultant team.

Program Overview

The City of Portland launched its five-year heat response program, "Cooling Portland," in 2022 in response to record breaking heat waves of 2021. The program provides free air conditioning units to heat-vulnerable populations in Portland. The program is funded by Portland Clean Energy Community Benefits Fund, with program administration by Earth Advantage. The mission of the program is to provide cooling to targeted priority populations as follows: residents over the age of 60, residents with medical conditions, and residents living alone. The program provides window and portable units and some units that provide heat and air conditioning (as shown in Figure 2-1). Units are distributed by local, trusted Community Distribution Partners, primarily nonprofit CBOs. Verde, alongside 10 other Community Distribution Partners were onboarded in the first year. In 2022 (the first year of the five-year program), over 3,000 units were provided and installed.

Figure 2-1: Cooling Equipment Options in the Cooling Portland Program

Figure 2-2 includes a breakdown of the kinds of units and when they were installed.

PORTABLE UNITS	WINDOWS	AC ONLY	HP-AC	OVER 10 AMP	LESS 10 AMP
3,207	350	1,010	2,547	2,150	1,407

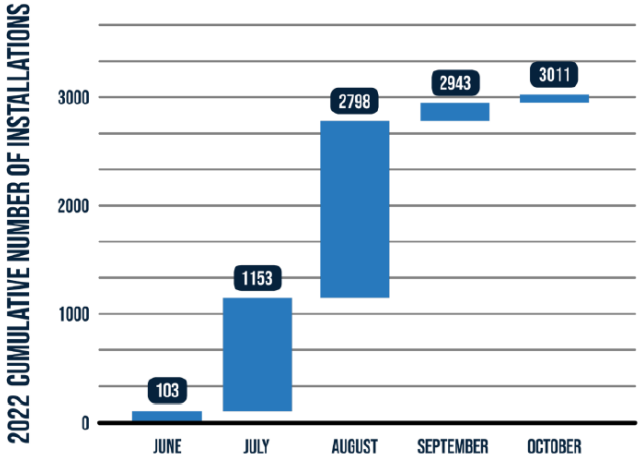


Figure 2-217: Cooling Portland Distribution Timeline

The area east of 82nd Avenue — where, as of 2011, much of Portland's minority population lives — had 46.18 percent of installations, a trend that is expected to continue. Approximately 28 percent of the total Portland population lives east of 82nd Avenue. The program's total spending within the first year was $3,174,282. The breakdown of spend by grant category is outlined in Figure 2-3 below. The estimated cost per portable unit delivered, including costs of installation, distribution, and personnel is an average of $1,000 per unit.

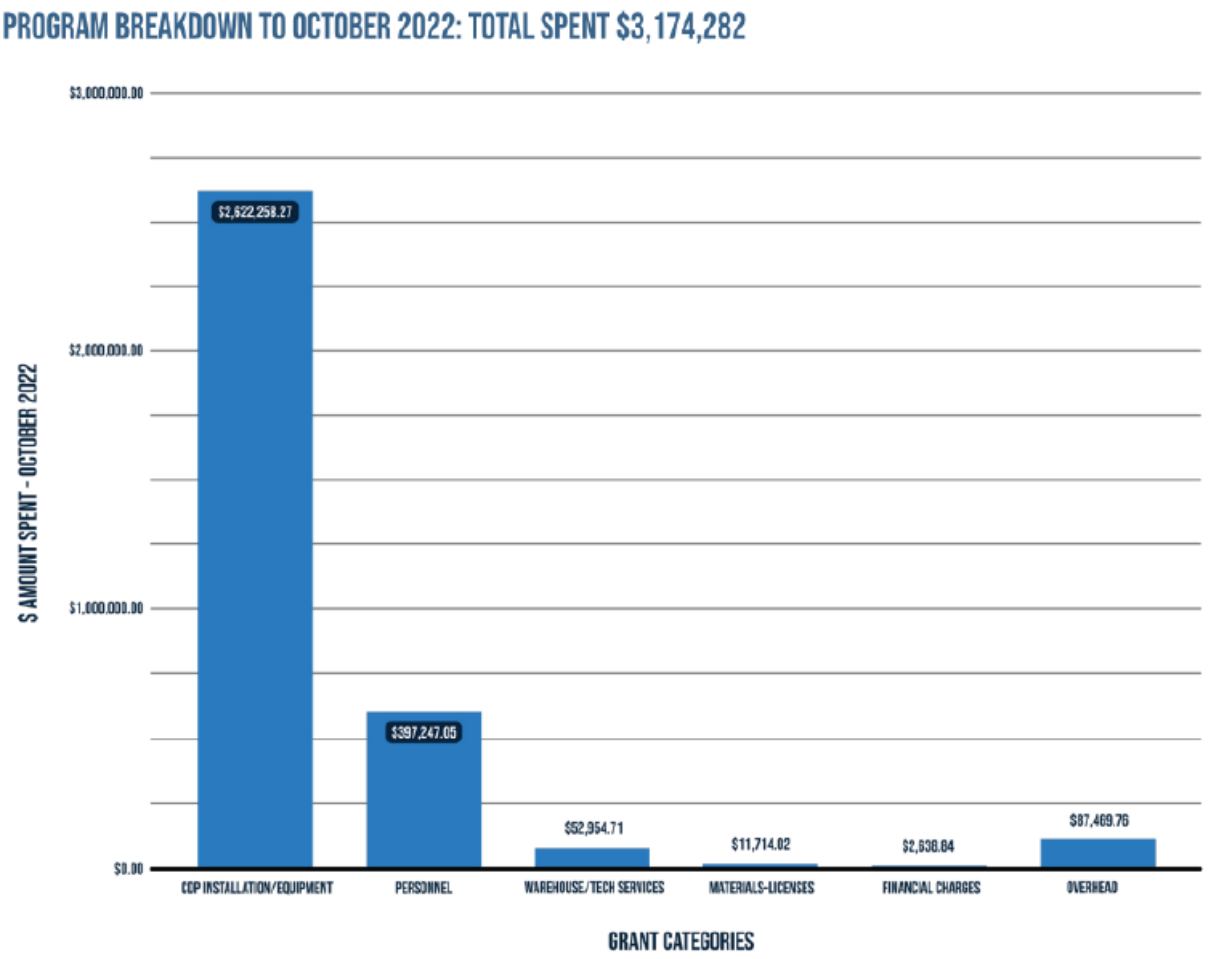


Figure 2-3: Cooling Portland Program Costs

Lessons Learned/Key Takeaways

- The partnership with Community Distribution Partners was crucial in building trust with priority populations and contributed to the overall success of the program.
- The CBOs word-of-mouth marketing within their service populations helped the program reach the most heat vulnerable populations in Portland.
    - Verde also identified the need to leverage the connections being made as an opportunity to distribute additional information on existing resources and other support programs that could be helpful to those in need, including bill assistance, rental assistance, and weatherization programs.
- Verde also acknowledged the importance of proactively positioning resources for efficient mass distribution.
    - Connecting with Earth Advantage and a warehouse to coordinate pairing needs with units for deployment contributed to the success of delivering over 3,000 units. The breadth of this operation requires assets and personnel for

deployment, including covered vehicles, vans, and long-term staffing for ongoing support.

- Meeting residents' cooling needs to go beyond just providing cooling equipment.
    - For those who currently don't have cooling, energy bills may increase drastically once equipment is introduced. Many priority population homes have poor insulation.
    - Housing assessments and weatherization should be part of unit deployment, which will help increase the efficiency of the provided unit and keep energy costs down for users. Likewise, including housing assessments as part of the process allows for potential follow-up activity related to cold weather and heating risks.

Barriers to Program Implementation

- Many older housing units have outdated electrical systems that may not support air conditioning capacity.
    - Upgrading electrical systems in whole buildings can be an expensive investment for property owners but continue to limit residents' access to adequate air conditioning.
    - Cooling programs should include resources for electrical system analysis and upgrade.
- Many multifamily units have restrictions against the use of portable air conditioning units, either by rule/restriction or due to limited electrical system capacity. Provisions may be needed to consider restrictions by multifamily and/or local constraints on installation.
- Verde also identified reaching non-English speaking communities as a challenge in connecting these vulnerable populations to much needed resources. Programs need to consider proper cultural and community engagement approaches to increase the likelihood of success to target populations.
- Verde found that mobile homes and RVs are more challenging housing types to equip with the kind of units their team was distributing due to space and capacity limits. These target populations may see greater benefit from other kinds of interventions and equipment types.

Highlight of Canopy of Stories Project

Canopy of Stories is a Multnomah County-based project completed by J'reyesha Brannon. The goal of this project is to "pair qualitative data (community stories and feedback) with quantitative data (temperature, tree canopy, maps) and visually present how climate change impacts our frontline communities in Multnomah County. Too often we see headlines and studies presenting 'disproportionate' impacts on Black/brown and low-income communities, but that work is often missing the personalization and community involvement of those most

impacted – in a vacuum of academia or government. This project aims to show the importance of qualitative data in the form of community stories and how it creates a fuller picture of how communities are impacted by lack of tree canopy, rising temperatures, and the resources needed."[18]

Following are the questions that were asked of participants and the highlights of their responses.

Questions from Canopy of Stories:

1) **How do extreme temperatures, like the heatwave in the summer of 2020 or the ice storm in the winter of 2021, impact you, your household and community?**
    - Many respondents expressed the heatwave added significant additional stress pertaining to additional financial costs, health and safety, and emotional distress.
    - Respondents expressed dealing with symptoms of heavy fatigue, rashes, and hives due to the heatwave.
    - There were concerns about how safe public cooling centers were due to COVID-19, and many people did not visit them because the cooling centers did not allow pets.
    - Many incurred unexpected expenses from purchasing air conditioning equipment, and residents expressed challenges with this added cost burden.
    - Many were unable to afford equipment at all.
    - Residents also expressed feeling alone and isolated and difficulties reaching out for help.
2) **Thinking about extreme heat, how do you stay comfortable in your home during the summer?**
    - For those without air conditioning, individuals responded that they went to cooler spaces, including home basements and air-conditioned public spaces.
    - Many keep their homes cooler by opening the windows at night, keeping fans running, keeping lights turned off, closing blinds during the day, and not cooking or using hot appliances.
    - Some kept themselves cool by wearing light clothing, using wet towels and ice packs, drinking cold water/eating cold foods, or standing in front of their open fridge or freezer.
    - Beyond all these actions, most expressed they ended up buying an air conditioning unit, which was an unexpected additional cost burden.
3) **What are things (e.g., trees providing shade, water fountains, public pools, shade spots, cooling centers) in your neighborhood that help you stay cool in the summer, and how have these things changed over the years (e.g., less trees to provide shade)?**
    - Multnomah County residents shared that trees, public parks, and pools are all important for keeping cool in the summer in their neighborhoods.

- Many expressed concerns that over the years these public assets have been closing without being replaced by new facilities.
- It was expressed that trees have been removed at alarming rates, and they are also not being replanted as fast as they are being removed.
- Residents also noted that many parks are either not well maintained or do not feel safe to visit.

4) **What supports (e.g., energy assistance programs, cooling and heating technology, transportation to cooling centers) would benefit you and your neighborhood during extreme heat or cold? What supports have helped in the past?**
    - Residents expressed that energy assistance programs and cooling centers have been helpful.
    - Many noted that expanded eligibility for energy assistance would be beneficial and wondered whether the addition of solar could help reduce energy costs.
    - While many respondents expressed that cooling centers were useful, the centers were not always accessible during extreme heat events.
        - Residents suggested that free transportation to cooling centers and allowing pets would increase their usefulness during emergency situations.
    - Most respondents suggested free air conditioning units or stipends to purchase heat pumps would be helpful but could still potentially be expensive.
    - Residents also recommended that all new buildings should be required to have air conditioning.

3. Geographic Information Systems Tools and Methodology

Heat Vulnerability Index

Overview

The HVI is designed to complement the survey data to identify populations across Oregon that are at the greatest risk and/or most vulnerable to the impacts of extreme heat. The HVI is an online, interactive GIS tool composed of existing publicly available data sources. The HVI can continue to be updated with new data and adjusted as needed for continued use and analysis. Instructions for updating the HVI are described in the GIS Methodology Technical Memorandum provided to the Oregon Department of Energy separately from this report alongside all GIS data files.

Heat vulnerability is assessed with the HVI using indicators related to physical sensitivity to heat and illness, level of exposure to heat, and the ability to adapt and recover from exposure events. This framework of assessing heat vulnerability through the combination of sensitivity, exposure, and adaptive capacity indexes illustrates differences in vulnerability throughout the state.

Indicators for the HVI were chosen for each of the indexes based on existing heat vulnerability literature, data availability, and discussions with ODOE and the Oregon Health Authority. This section describes the framework and methodology behind the HVI along with a description of the data sources and indices used.

Framework

The HVI is a combination of the three separate indexes: Exposure, Sensitivity, and Adaptive Capacity. Each individual index is composed of multiple indicators. Each indicator is scored based on a standardization method in which the value of that indicator is divided by the largest value within the data series to quantify a score between 1 and 100. Scores for the indexes are calculated as an average of the scores for each indicator. All three indexes are averaged to create the Overall Heat Vulnerability Index. The Heat Vulnerability Index illustrates data at the county and census-tract levels. Each of the indexes and associated data sources are described as follows.

Exposure Index

The Exposure Index measures the range of environmental exposure to heat and anticipated heat increases alongside indicators such as tree canopy and impervious surface to identify potential heat islands (see Table 3-1). The Exposure Index is made up of the following inputs:

- Days over 90°F threshold – Higher temperatures have the potential to impact human health, especially in areas with minimal access to air conditioning and for populations not already adapted to heat. This indicator is a measure of the current baseline conditions.

- Increase in days over 90°F threshold – As the climate continues to change, days over 90°F and overall temperatures are predicted to increase statewide. This indicator measures the anticipated percentage of change from the baseline.
- Impervious surfaces – Impervious surfaces hold heat as thermal mass and may be hotter than other surfaces like grass, contributing to the urban heat island effect. Impervious surfaces also release heat at night, which can contribute to dangerous evening temperatures.
- Tree canopy coverage – This indicator illustrates the percent of land covered in trees and shrubs. Tree canopy coverage provides direct cooling for homes and urban neighborhoods, although this effect may be negligible for taller buildings. In neighborhoods with large amounts of paving, trees may reduce the area's overall temperature.

Table 3-1: Exposure Index Data Sources

Indicator	Description	Data Source
Heat Exposure	Recent average (2017–2021) number of days over 90% relative heat index	CDC Environmental Public Health Data Explorer
Increasing Heat Exposure	Historic average (1979–1983) vs recent average (2017–2021) change in number of days over 90% relative heat index	CDC Environmental Public Health Data Explorer
Tree Canopy Coverage	Percent of land area covered with trees and shrubs	National Land Cover Dataset 2016
Impervious Surface Coverage	Percent of land area covered with impervious surface	National Land Cover Dataset 2019

Notes: CDC – Centers for Disease Control

Adaptive Capacity Index

The Adaptive Capacity Index measures socioeconomic, demographic, and place-based factors that can affect an individual's ability to cope with change (see Table 3-2). This includes identification of communities and populations who have been historically disadvantaged and

marginalized due to discriminatory policies and practices. "As a result of the underlying sociological, economic, and policy drivers that perpetuate inequalities, low-income households and communities of color continue to be disproportionately exposed to higher levels of pollution and thus have higher rates of physiological risk factors."[19] The Adaptive Capacity Index is made up of the following inputs:

- People of Color – May experience greater impacts a result of historical oppression and inequalities (e.g., redlining) and being overburdened with exposure to environmental pollution.
- Low Income Population – Low-income individuals have less access to resources to meet their comfort and safety needs, including purchasing air conditioning or the ability to afford increased energy bills from using cooling equipment.
- Educational Attainment (less than high school degree) – Lower education attainment is often paired with lesser access to financial resources and self-advocacy.
- Limited English-Speaking Households/Linguistic Isolation – Language barriers create barriers for residents seeking help in times of need and can lead to decreased access to education and resources.
- Access to Vehicle – Having access to a vehicle is generally associated with having greater access to resources and lack of access may preclude individuals from seeking respite in air-conditioned spaces or cooling shelters in extreme heat events.
- Outdoor employment (agriculture, forestry, fishing, and hunting; mining, quarrying, and oil and gas extraction; utilities; and construction jobs likely to be performed outside) – These professions increase an individual's daily exposure to extreme heat.
- Housing Condition (built before 1980) – This factor identifies older housing stock that is less likely to have adequate weatherization, electrical, and equipment for meeting residents' cooling needs.
- Foreign-born population – This factor takes into consideration residents that may be less aware of or well connected to public resources, immigration status barriers, and challenges that arise from not knowing cultural norms.

Table 3-2: Adaptive Capacity Index Data Sources

Indicator	Description	Data Source
People of color	Population identifying as not Hispanic and white	ACS 2021 – B03002
Low-income population	Income less than 2x federal poverty level	ACS 2021 – C17002

Educational attainment	Less than bachelor's degree	ACS 2021 – S1501
Limited English speaking	Population speaking English "not well"	ACS 2021 - C16002
Access to vehicle	Population with access to vehicle	ACS 2021 –B25055
Outdoor employment	Population working resource and construction jobs likely to be performed outside (includes jobs in NAICS sectors 11 [Agriculture, Forestry, Fishing and Hunting], 21 [Mining, Quarrying, and Oil and Gas Extraction], 22 [Utilities], 23 [Construction])	Census Bureau OnTheMap 2020 – LEHD Data
Housing condition	Population in housing built before 1980	ACS 2021 – B25036
Foreign-born population	Population not born in United States	ACS 2021 – DP02

Notes: ACS – American Community Survey; LEHD – Longitudinal Employer-Household Dynamics; NAICS – North American Industry Classification System

Sensitivity Index:

The Sensitivity Index measures the age and health factors that may increase an individual's physiological vulnerability to negative health impacts from exposure to extreme heat (see Table 3-3). The Sensitivity Index is made up of the following inputs:

- Population less than five years old – Young children are more sensitive to heat exposure as their smaller body mass to surface area ratio make them more vulnerable to heat-related illness.
- Population less than 18 years old – While the impacts are greatest for children five years and younger, all children are more sensitive to environmental factors than adults.
- Population over 65 years old – Older individuals are more sensitive to heat and more likely to have preexisting health conditions that create compounding impacts when combined with heat exposure.
- Living alone and 65 or older – Socially isolated older adults are at greater risk of heat-related death. This population was identified as the most vulnerable group in the

2021 heat dome event, according to Multnomah County. On the other hand, having strong social ties and/or living with others are considered protective factors.

- Population age 18 to 64 without health insurance – Individuals without health insurance are less likely to have access to resources to protect their ongoing health and wellness, putting them at higher risk of being impacted by instances of extreme heat.
- Diabetes (diagnosed diabetes among adults aged equal to or over the age of 18 years) – People with diabetes are at greater risk of experiencing dehydration and cardiovascular challenges during periods of extreme heat.
- Heart disease (coronary heart disease) – Hot weather causes the human body to work harder to keep core temperatures regulated, putting extra strain on the heart. Due to this, individuals with heart disease are at greater risk of being negatively impacted during heat events.
- Poor physical health – Individuals with poor physical health are more likely to have illnesses that increase their health vulnerability to heat exposure.
- Poor mental health – Individuals with poor mental health may face additional barriers or challenges reaching out for help during extreme heat events and are therefore at a greater risk of being negatively impacted.
- Cancer (except skin) crude prevalence – The Oregon Health Authority indicated that individuals with cancer may be more vulnerable to heat and compounding health impacts.
- Persons with Disabilities – Individuals with disabilities are at greater risk of heat-related illness and are more likely to have mobility impairments that further impact their ability to seek respite and overall levels of heat exposure.

Table 3-3: Sensitivity Index Data Sources

Indicator	Description	Data Source
Young children	Population less than 5 years old	ACS 2021 - DP05
Dependents	Population less than 18 years old	ACS 2021 - DP05
Older adults	Population over 65 years old	ACS 2021 - DP05
Older adults living alone	Population over 65 years old living alone	ACS 2021 - B09020

No health insurance	Population age 18 to 64 without health insurance	CDC Places
Diabetes	Diagnosed diabetes among adults equal to or over the age of 18	CDC Places
Heart disease	Coronary heart disease prevalence	CDC Places
Poor physical health	Physical health not good for equal to or over 14 days among adults equal to or over the age of 18	CDC Places
Poor mental health	Mental health not good for equal to or over 14 days among adults equal to or over the age of 18	CDC Places
Cancer	Cancer (excluding skin cancer) crude prevalence	CDC Places
Persons with disabilities	Disability status	ACS 2021 – S1810

Notes: ACS – American Community Survey; CDC – Centers for Disease Control

Additional Context Layers

The following layers were included in the HVI online tool to provide additional context about the housing types and factors relevant to this study. These layers are intended to be viewed alongside the HVI but are not included in the weighting of the index to measure heat vulnerability. The additional context layers are as follows:

Housing Context Layers – Illustrate where each of the housing types are located and concentrated statewide along with other useful context layers that were not included in the weighting of the HVI (see Table 3-4).

Table 3-4: Housing Context Layer Data Sources

Indicator	Description	Data Source
Publicly supported housing (multifamily)	Displays where all publicly supported housing is located statewide, including number of units per development and percent energy burdened households.	OHCS Oregon Affordable Housing Inventory 2022
Multifamily – seniors	Displays number of publicly supported multifamily units per county designated for elderly adults.	OHCS Oregon Affordable Housing Inventory 2022
Multifamily – seniors with rental assistance	Displays the number of publicly supported multifamily units per county designated for elderly adults receiving rental assistance.	OHCS Oregon Affordable Housing Inventory 2022
Multifamily – built pre-1980	Displays the number of publicly supported multifamily units per county built before 1980.	OHCS Oregon Affordable Housing Inventory 2022
Manufactured/mobile home properties	Displays where all manufactured/mobile developments are located statewide, including park name, number of spaces, park type, and percent energy burdened households.	OHCS Manufactured Home Parks
Manufactured/mobile home properties – seniors	Displays where all manufactured/mobile developments that are 55+ are located statewide.	OHCS Manufactured Home Parks
Mobile home properties – built pre-1980	Displays the number of mobile homes per county built before 1980.	OHCS Manufactured Home Parks

Indicator	Description	Data Source
Percent (%) manufactured/ mobile	Displays the total number of manufactured/mobile units per county and the percent of manufactured/mobile homes.	ACS 2020
Boat, van, RV, etc.	Displays the number of units in boat, van, RV, etc. per county and the percent of boats, vans, RVs, etc.	ACS 2021 – B25055
Agricultural Labor Housing Registry	Displays where all active agricultural labor housing sites are located statewide, including maximum occupancy numbers per site.	Oregon DCBS – ALH8004 - Ag Labor Housing Registry
Percent (%) renters	Displays the total population per county, the number of renter occupied housing units, and the percent of renter occupied housing unit.	ACS 2021 – B25055
Precent (%) housing cost burdened households	Displays the percentage of housing cost burdened households per county.	ACS 2021 – S2503
Oregon Cooling Zones	Displays the Cooling Zones in Oregon.xi	ETO Cooling Report

Notes: ACS – American Community Survey; ETO – Energy Trust of Oregon; OHCS – Oregon Housing and Community Services

Exposure Layers – Illustrate additional factors that could be used to understand exposure to heat that were not included in the weighting of the HVI (see Table 3-5).

[xi] This layer was used to indicate cooling needs throughout the Oregon before the HVI tool was created. Counties in Cooling Zones 2 and 3 were prioritized for outreach to those in publicly supported housing, manufactured/mobile homes, and residential RVs.

Table 3-5: Exposure Context Layer Data Sources

Indicator	Description	Data Source
Population density	Tract/county population density per square mile divided by max tract/county percent.	ACS 2021
Household density	Tract/county household density per square mile divided by max tract/county percent.	ACS 2021
Urban heat island intensity	Shows heat island severity in cities on scale of 1 to 5 generated from Landsat imagery	Trust for Public Land
Annual days over 90°F – maximum	Displays the maximum number of annual days over 90°F in any location per county.	Climate Toolbox
Annual days over 90°F – average	Displays the average number of annual days over 90°F per county.	Climate Toolbox
Increase in annual days over 90°F – maximum	Displays the projected increase in the maximum number of annual days over 90°F in any location per county.	Climate Toolbox
Increase in annual days over 90°F – average	Displays the projected increase in the average number of annual days over 90°F per county.	Climate Toolbox

Note: ACS – American Community Survey

Sensitivity Layers – Illustrate additional factors that could be used to understand sensitivity to heat[xii] and were not included in the HVI (see Table 3-6).

[xii] While this study did not find any specific ties to asthma or COPD and heat vulnerability in its review of existing literature, these reference layers are included because they are very likely to be compounding factors when considering heat in relation/addition to wildfire smoke exposure.

Table 3-6: Sensitivity Context Layer Data Sources

Indicator	Description	Data Source
Asthma prevalence	Displays the asthma prevalence per county as a percentage of the population.	CDC Places
COPD prevalence	Displays the COPD prevalence per county as a percentage of the population.	CDC Places

Note: ACS – American Community Survey; COPD – chronic obstructive pulmonary disease

HVI Results

Each index measures vulnerability by both the county and census block group levels, which can be viewed separately in the online HVI tool. All data provided for each of the indexes were normalized dividing all values within each indicator by the maximum value of that indicator, ensuring all values for all indicators are represented by a score between 0 and 1. The scores quantified for the sensitivity, exposure, and adaptive capacity indexes are an average of all normalized indicator scores by county/census block group. The overall heat vulnerability index is an average of the exposure, sensitivity, and adaptive capacity scores by county/census block group. For all indices, higher scores increased greater vulnerability.[xiii] Figure 3-1 shows a map of the overall HVI results, and Table 3-7 below displays the top six counties that rank highest on the overall Heat Vulnerability Index.

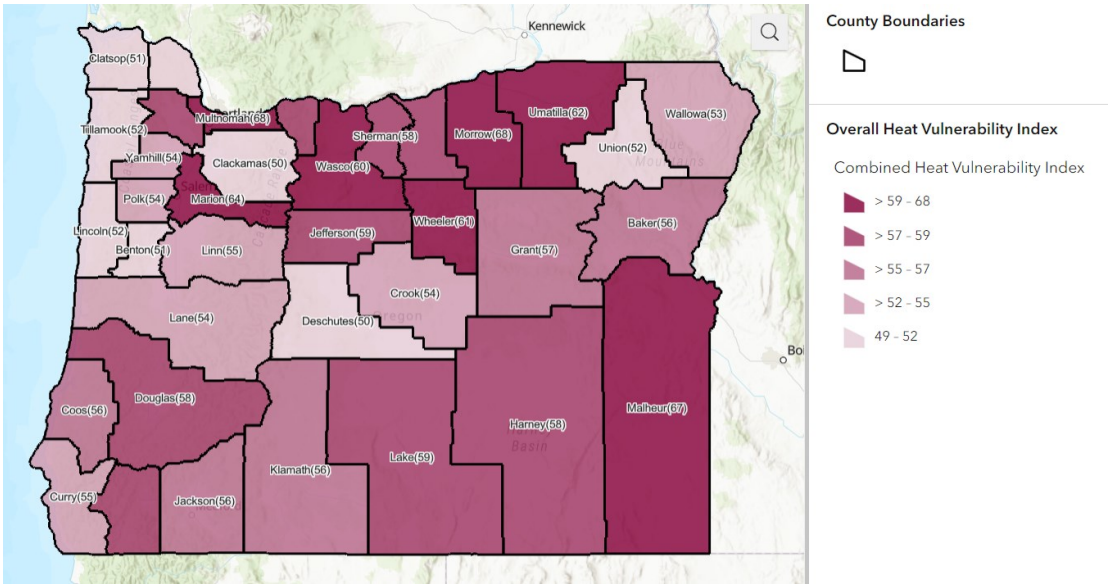


Figure 3-1: Map of Overall Heat Vulnerability Index Results

[xiii] For the Adaptive Capacity Index, higher scores indicate populations with less adaptive capacity.

Table 3-7: Top Six Counties Ranking Highest on the Heat Vulnerability Index

Top 6 Most Vulnerable Counties	Overall HVI Score
Morrow County	68
Multnomah County	68
Malheur County	67
Marion County	64
Umatilla County	62
Wheeler County	61

Exposure Index Results

Exposure measures a region's exposure to increasing heat and compounding factors, including tree canopy coverage and impervious surface coverage. Figure 3-2 shows the map of the Exposure Index results, and Table 3-8 below displays the top six counties that rank highest on the Exposure Index.

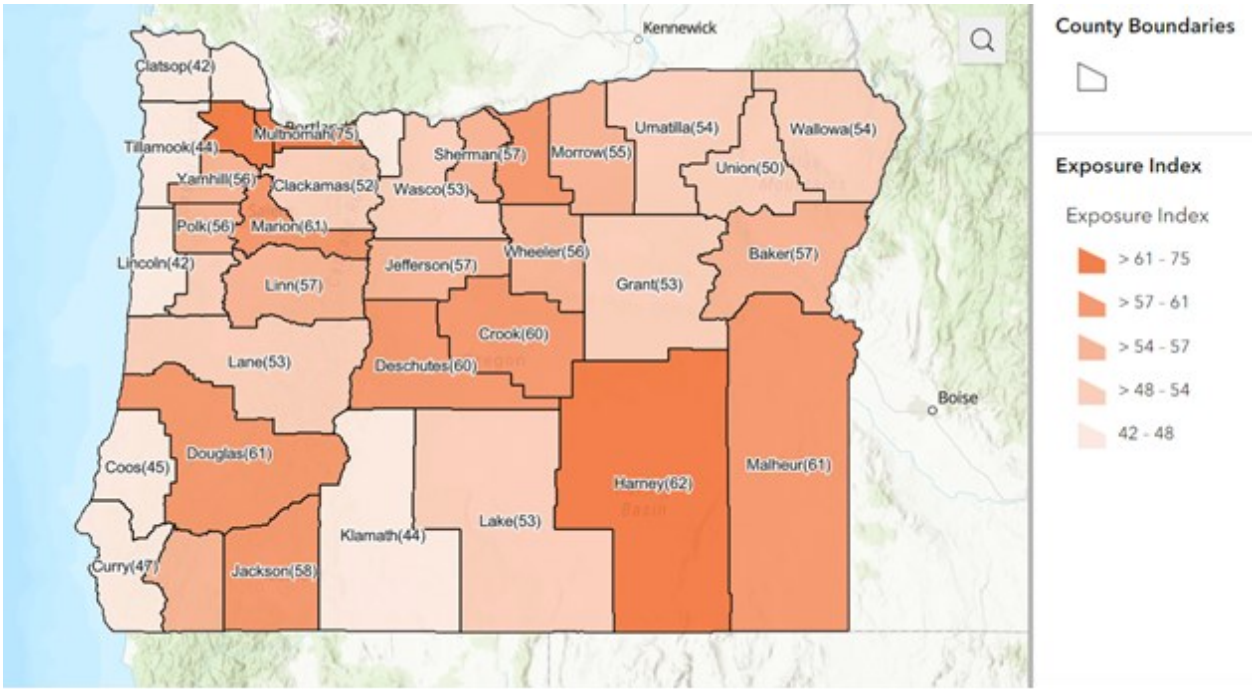


Figure 3-2: Map of Exposure Index Results

Table 3-8: Top Six Counties Ranking Highest on the Exposure Index

Top 6 of Exposure Index	Exposure HVI Score	Overall HVI Score
Multnomah County	75	68
Washington County	63	58
Harney County	62	58
Malheur County	61	67
Marion County	61	64
Douglas County	61	58

Adaptive Capacity Index Results

Adaptive Capacity measures residents' ability to cope and recover from extreme heat events based on preexisting conditions, factors, and historical oppression. Figure 3-3 shows a map of the Adaptive Capacity Index results, and Table 3-9 below displays the top six counties that rank highest on the Adaptive Capacity Index.

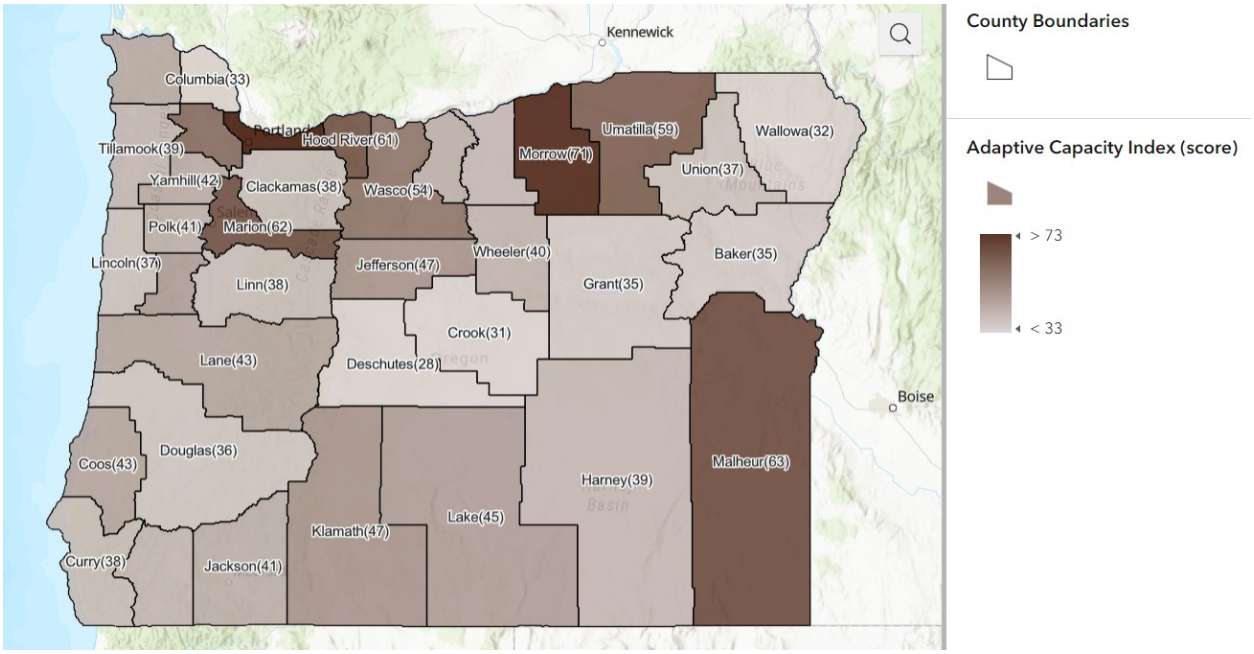


Figure 3-3: Map of Adaptive Capacity Index Results

Table 3-9: Top Six Counties Ranking Highest on the Adaptive Capacity Index

Top 6 of Adaptive Capacity Index	Adaptive Capacity HVI Score	Overall HVI Score
Multnomah County	73	68
Morrow County	71	68
Malheur County	63	67
Marion County	62	64
Hood County	61	58
Umatilla County	59	62

Sensitivity Index Results

The Sensitivity Index measures the degree to which a population's health may be impacted by heat-related hazards. Figure 3-4 shows a map of the Sensitivity Index Results, and Table 3-10 below displays the top six counties that rank highest on the Sensitivity Index.

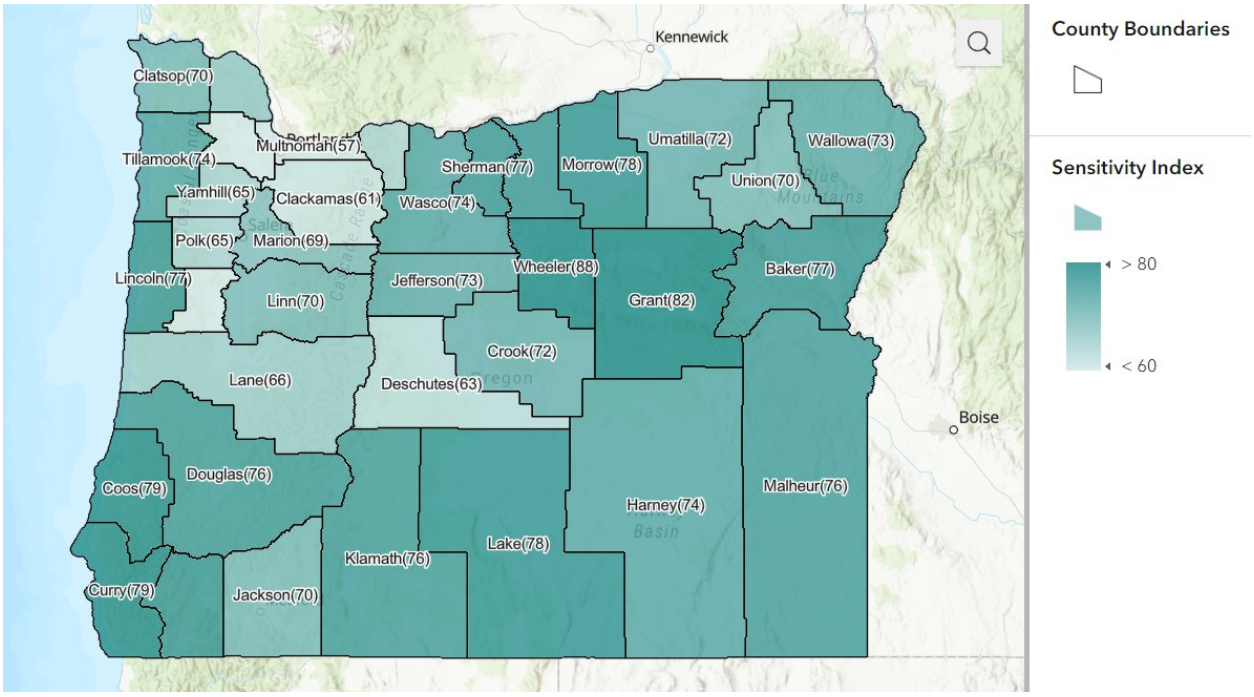


Figure 3-4: Map of Sensitivity Index Results

Table 3-10: Top Six Counties Ranking Highest on the Sensitivity Index

Top 6 of Sensitivity Index	Sensitivity HVI Score	Overall HVI Score
Wheeler County	88	61
Grant County	82	57
Curry County	79	55
Coos County	79	56
Morrow County	78	68
Lake County	78	59

Spatial Discrepancies, Limitations, and Intended Use

Spatial Discrepancies

The results of the vulnerability analysis are displayed via the county- and census-tract levels, which can be viewed separately in the HVI tool. High vulnerability counties/census tracts are displayed next to low-vulnerability counties/census tracts based on relative scoring. Vulnerability is not displayed in a gradient when visualized in the tool. The scores are a composite score of the county or census tract. Counties or census tracts with smaller populations over a wider geographic space may have skewed scores. For example, the Malheur County results for the whole county may be skewed by the City of Ontario, a small land portion of the entire county. Conversely, Clackamas County is largely rural, with exception for the piece that makes up Portland Metropolitan area. Tree canopy for this county at the county level will be skewed by the rural areas but may not fully represent the urban area that has less dense tree canopy coverage. Further research will be required to target specific populations for policy and programmatic interventions.

Limitations

Our team focused on gathering the best quality data available, but the HVI is based on large-scale data estimates that all have biases and margins of error, depending on how studies were conducted. The data may not fully and accurately represent places and people or how heat and health are experienced throughout all areas of the counties or census tracts. The HVI is best used to identify potential trends for further exploration to better understand extreme heat impacts to inform programs and intervention approaches. While different weighting and normalization of these variables could change the HVI index results, the current approach was chosen in collaboration with ODOE, OHA, and the consulting team to understand heat-related vulnerability in Oregon. The tool is intended to be updated as new data becomes available and the scoring methodology can be easily altered and improved if a better approach is identified.

Intended Use

The HVI provides a geospatial analysis of the corresponding indices related to heat vulnerability and risks related to heat-related illness across the state by the county- and census-tract levels. The framework for this index assesses vulnerability as a function of the intersectionality of heat sensitivity, exposure risk, and adaptive capacity. This tool can be used to identify populations at the highest risk of heat-related illness, which can inform policy and programmatic interventions to better serve the populations with the greatest cooling and associated needs. This tool is best used as a resource to explore trends that show populations are experiencing risk disproportionately, enhance intervention efforts, and identify communities where additional targeted outreach is needed.

4. Currently Available Financial Incentives

Statewide

Oregon Department of Energy

- Community Heat Pump deployment program:[20] This ODOE program provides grants to eligible organizations to provide assistance to residents for the purchase and installation of heat pumps and heat pump upgrades. The grant is open to Oregon Tribes, local governments, local housing authorities, nonprofit organizations, coordinated care organizations, community action organizations, manufactured dwelling nonprofits, and electric utilities.
- Oregon Rental Homes Heat pump program:[21] This program provides rebates and grants for the installation and upgrades for heat pumps in rental dwellings including manufactured homes and recreational vehicles located in a rented space.

Energy Trust of Oregon

- Heating solutions for residents:[22] ETO offers rebates between $200 and $1,650 on energy efficient heat pumps installed by an approved contractor for detached single-family or multifamily homes in Oregon that are serviced by Portland General Electric, Pacific Power, Northwest Natural, Cascade Natural Gas, or Avista.
- Landlord Provided Cooling Spaces Initiative:[23] This initiative has tiered incentives.
    - For priority properties, defined as Tribal housing, affordable multifamily housing, nonprofit-managed multifamily housing, senior housing, agricultural workforce housing, and manufactured home parks:
        - 100 percent of project costs reimbursed, up to a maximum of:
            - $1,400 for portable or window air conditioners (maximum of $700 per unit).
            - $7,000 for ductless heat pumps, heat pumps and hard-wired air conditioners.
    - For all other properties:
        - 60 percent of project costs reimbursed, up to a maximum of:
            - $800 for portable or window air conditioners (maximum of $400 per unit).
            - $4,000 for ductless heat pumps, heat pumps and hard-wired air conditioners.

Oregon Health Authority

- OHA Healthy Homes Program,[24] currently in development and expected to launch 2024: This program will provide financial assistance to local governments, local housing authorities, nonprofit organizations, Tribal entities, coordinated care centers, community action agencies, and electric and natural gas utilities to distribute to residents, homeowners, and landlords to repair and rehabilitate dwellings to address health and safety hazards.

Utilities

Portland General Electric

- Income-Qualified Bill Discount Program:[25] Individuals whose income and housing sizes qualify can receive 15 to 25 percent monthly discount on their energy bills with PGE.

Eugene Water and Electric Board

- Residential Incentives - Rebates, Loans & Conservation:[26] EWEB offers a variety of rebates and loans for homes or rental properties to help offset the upfront cost to upgrade windows, insulation, and appliances. They also provide payment assistance programs.

Umatilla Electric Cooperative

- Energy Efficiency programs:[27] Umatilla Electric Cooperative offers a variety of program options to save users energy and money for residential homes and commercial businesses.

Northwest Natural

- Bill Discount Program:[28] NW Natural offers a bill discount program that can save users 15 to 40 percent on monthly bills if income qualifies.

Incentives Available by County

Oregon Housing and Community Services

- Utility Bill Payment Assistance:[29] Oregon Housing and Community Services provides funds to local community agencies that provide bill payment assistance programs. These programs assist low-income households to make their energy costs more affordable.
- Weatherization Assistance Program:[30] This program is federally funded, providing low-income households with weatherization support services to increase home energy efficiency and promote energy savings.

Community Action Partnership of Oregon:

- Community Action Agencies:[31] Across the state, CAAs provide support services for residents and offer the above listed programs in addition to many other services, including rental assistance and emergency food and shelter, catered to the needs of each community.

Community-Based Organizations

Many other additional programs exist throughout the state, provided by the CBO partners who participated in this study and others.

More incentives, rebates, grants, and tax credit programs in Oregon can be found at DSIRE (dsireusa.org).

Federal Funding Opportunities

Inflation Reduction Act

- Federal tax credits:[32] For the 2023 tax year, households will be able to claim a tax credit for 30 percent of the costs of buying and installing a heat pump, up to $2,000, including support for any electric system upgrades needed to make the home heat-pump-ready.
- Incentive programs under the IRA (not yet available):
    - High-Efficiency Electric Home Rebate Program[33] – will provide point-of-sale rebates to low- and moderate-income customers (households with up to 150 percent of Area Median Income) for home electrification measures, including heat pumps.
    - Home Energy Rebates Programs[34] – grants money to states to develop a rebate program for whole-house energy saving retrofits.

Office of State and Community Energy Programs

- Energy Efficiency and Conservation Block Grant Program:[35] This program is designed to assist state and local governments and Tribes in implementing strategies to reduce energy use, improve energy efficiency, and reduce fossil fuel emissions. This fund allocates $550M dollars nationally for distribution.

5. Endnotes

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