Home Forward Indoor Temperature Assessment

Final Report

April 2023

Report prepared by CAPA Strategies, LLC
for the City of Portland Bureau of Emergency Management

Executive Summary

In early 2022, the City of Portland Bureau of Emergency Management (PBEM) initiated an effort to track summer temperatures inside of public/affordable housing units, in partnership with Home Forward, the local Housing Authority. The Multnomah County Health Department (MCHD) also joined the project as a consulting partner. This action was taken in response to the 'heat dome' event of 2021, which resulted in 69 fatalities in Multnomah County, including multiple residents who lived in public/affordable housing. PBEM contracted the climate adaptation consultancy CAPA Strategies to monitor summer temperatures in three Home Forward properties – Hollywood East (HWE), Northwest Tower (NWT), and Peaceful Villa (PV) – and to gather social data allowing the project team to better understand residents' experiences with regard to summer heat.

Temperature sensors were placed in a total of 53 residential units in June and July, and recorded indoor temperatures at 30-minute intervals through late September, 2022. In addition to logging temperature data, these sensors alerted residents – with an alarm sound, a text message alert, and/or an email alert – when temperatures in their units exceed 80, 85, and 90°F. Residents were engaged in a complementary social survey covering four main topics: (1) demographic information, (2) experiences with indoor heat and heat-related illness, (3) perceptions of heat risk and preparedness, and (4) coping strategies. Finally, in January of 2023, two workshops were held with participating residents from HWE and NWT. There, residents were able to expand upon their survey responses and share additional information; view and comment on temperature study findings; and provide ideas for improving thermal conditions in those two properties. This approach subverted a conventional, top-down model of hazard-description and solutions-development, and enabled the project team to learn from heat-affected residents.

Temperature data were analyzed in five ways: (1) summary statistics for each unit, (2) maximum temperature range for each building story, (3) hourly temperature profile for each unit and property, (4) exceedances of temperature thresholds (80, 85 and 90°F) for each property, and (5) maximum temperature by unit characteristics. Results show that units in all three properties reached over 80°F on a regular basis throughout the summer, with several units in HWE and NWT exceeding 85 and even 90°F. Units in the lower-profile, wooden structures of PV became less hot than those in the two concrete high-rise properties (HWE and NWT), suggesting a relationship between building form, materials, and indoor temperature. Other unit characteristics – the presence of air conditioning somewhere in the unit (not necessarily in the same room as the temperature sensor), the direction of windows, and the presence of tree shade – did not appear to significantly affect indoor temperatures. Higher-level stories also did not emerge as significantly hotter than lower stories in high-rise structures. Additional information gleaned from resident workshops helped to clarify these unexpected findings. Survey and workshop results support the notion that concrete high-rises retain heat particularly efficiently and that residents are negatively impacted by heat exposure. Some residents of HWE and NWT noted heat coming off of internal walls into the early evening and struggling to keep their units cool even with fans and air conditioners. Over 70% of all participants experienced difficulty sleeping due to heat, while many experienced heat-related stress, irritability, headaches, and other physical symptoms. Actionable requests for assistance included central or expanded air conditioning, access to screens so that windows can be opened without bugs getting in, and extended hours for on-site cooling centers, among others presented here.

Following a review of temperature and survey study findings, this report offers a deeper, workshop-informed examination of how residents are using air conditioners or otherwise cooling their units, how cooling center accessibility can be improved, and what resources would increase feelings of preparedness and safety. Recommendations have been developed based on those initial study findings, resident feedback collected via workshops, and input from project partners. These findings offer some novel insights into the experiences of summer heat for public/affordable housing residents. The preliminary conclusions and recommendations conveyed in this report would benefit by further study. It is recommended that this work be continued with additional participation to increase understanding about the impacts of air conditioning, tree shade, building height, and window direction.

Home Forward
Indoor Temperature Assessment

Project Overview

1. Place
Place temperature sensors inside homes

2. Record
Record summer temperature data

3. Survey
Survey residents on their experiences with heat

4. Workshop
Workshop study findings and possible solutions with residents

5. Share
Share results with residents and partners

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Background Overview

In January of 2022, the City of Portland Bureau of Emergency Management (PBEM) initiated and funded an effort to track summer temperatures inside of affordable housing[1] units, in partnership with Home Forward, the local Housing Authority. The Multnomah County Health Department (MCHD) also joined as a consulting partner. This project was undertaken in response to the 'heat dome' event of 2021, which resulted in 69 fatalities in Multnomah County. Most fatalities occurred inside homes, and these included several residents who lived in affordable housing. Home Forward staff expressed to the City a desire to better protect residents against heat-related illness. City emergency managers (PBEM) and MCHD had also identified low-income, affordable housing residents as highly vulnerable to extreme heat and sought to improve their understanding of appropriate interventions. Collectively, these agencies articulated a mission to capture indoor temperature conditions within affordable housing units, elucidate residents' experiences with heat, including challenges and adaptive strategies, and leverage data to improve future heat preparedness measures, emergency responses, and building design guidelines.

The City of Portland contracted CAPA Strategies (CAPA), a climate consulting firm, to design, manage, and execute this study known as the Home Forward Indoor Temperature Assessment. Using a systematic approach that combined environmental monitoring (via temperature sensing) and social scientific research techniques, CAPA completed an 8-month assessment across three Home Forward properties. This included continuous temperature monitoring in 53 residences during the summer of 2022; a social survey of participating residents to capture both quantitative-environmental and qualitative data; and two resident workshops to further clarify temperature findings and appropriate next steps. This approach subverted a conventional, top-down model of hazard-description and solutions-development, and enabled the project team to learn from heat-affected residents.

This report provides an explanation of all assessment activities, an overview of data analysis and findings, and practical recommendations. The recommendations were developed in consultation with PBEM, Home Forward, and MCHD and reflect empirical study findings, as well as resident feedback collected during workshops.

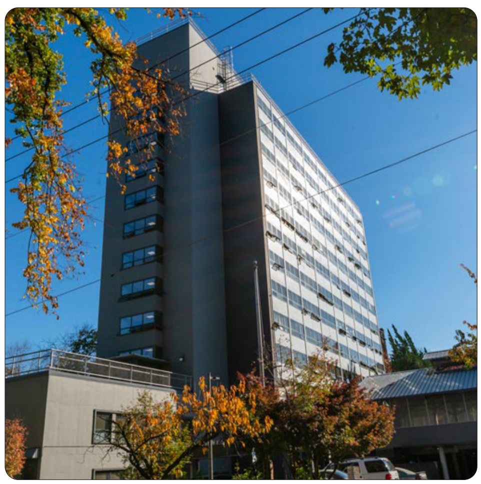
[1] Home Forward operates both affordable housing and public housing properties. This study includes two Section 8 affordable housing properties and one public housing property. Throughout this report, the phrase "affordable housing" will be used to refer collectively to both types of housing.

Study Design & Methods

Three Home Forward properties located in the City of Portland (OR) were selected for inclusion in this study: Hollywood East (HWE), Northwest Tower (NWT), and Peaceful Villa (PV). These properties were selected for a variety of qualities including past incidence of heat-related mortality, geographic location, building characteristics, and availability of building managers to assist the project team. The final selection included two high-rise properties (HWE & NWT) and one community of single- and two-story homes (PV). NWT features a three-story Annex, a separate structure, which was included in this study.

Summary of Building Characteristics							
Property Name	**Location in Portland**	**Building Type**	**Primary Building Material**	**Number of Units**	**Type of Units**	**Number of Stories**	**Heat-Related Death in 2021**
Hollywood East	Northeast	High-rise	Concrete	286	Studio, 1-Bed, 2-Bed	14	No
Northwest Tower	Northwest	High-rise plus annex	Concrete	150	Studio, 1-Bed	13 main, 3 annex	Yes
Peaceful Villa	Southeast	Freestanding multi-unit structures (16)	Wood	69	Studio, 1-Bed, 2-Bed	1 - 2	Yes

Hollywood East



Northwest Tower

Peaceful Villa

Participant Recruitment

Residents were to be engaged initially in a two-pronged process of (1) indoor summer temperature monitoring and (2) a survey of their experiences with heat. In May of 2022, posters advertising the study were placed in common areas of HWE, NWT and PV. The following month, property managers contacted all residents with a printed letter describing the study in greater detail, and a response card with which residents could express their interest in participating. The recruitment letter was provided in English, Spanish, Vietnamese, or Russian depending on the preferred language of each resident, as identified by Home Forward management.

A total of 87 positive responses were received, and consisted of 42 from HWE, 34 from NWT, and 11 from PV. A total of 53 residents were selected to participate in the study – 24 from HWE, 23 from NWT, and 6 from PV – based on the location of their units within each property (see the *Temperature Sensors* section below for a description of sensor placement methods) and on the availability of sensors. In early autumn, participating residents were compensated a total of $70 after keeping a temperature sensor in their homes over a three-month period and taking a survey.

The same residents from HWE and NWT who participated in the temperature monitoring and survey were contacted again in December of 2022, via a printed letter, and invited to participate in a workshop at their respective properties. Fourteen residents from HWE and 15 residents from NWT signed up, though not all attended. Ultimately, 12 residents participated in the workshop at HWE, and 13 in the workshop at NWT. Those who attended were compensated $70 for a 3.5-hour event.

Temperature Sensors

Temperature sensors were placed in participating units between June 30th and July 14th, and were removed on September 23rd, 2022. Depending on the installation date, sensors were in residences for 72-86 days.[2] Data points were remotely uploaded to the cloud in 30-minute intervals during this time period. Multiple sensors were reviewed for the project, including TempStick, Onset HOBO, and UbiBot WS1 Pro for several criteria, including:

- Data can be uploaded to the cloud (via a console) and can be tracked at will by members of the project team.
- Temperature and humidity readings are available on a display (i.e. digital screen) for resident viewing at any time.
- The sensor can send alerts when the temperature exceeds a set threshold. For this study, alerts needed to be triggered when indoor temperatures exceeded 80, 85, and 90 degrees Fahrenheit (°F).
- The sensor could run on a cell signal using a SIM card and pre-purchased data.

Based on these criteria, the UbiBot WS1 Pro was selected, and had several advantages over the other two, such as the ability for residents to choose from an alert chime on the sensor, a text message alert, and an email alert. Alerts received via text or email were customized with messages advising residents of the temperature and reminding them where to seek assistance if needed. Additionally, the UbiBot WS1 Pro sensor operates on a cell signal and SIM data, while other options require a wifi or bluetooth connection. This feature was essential given that Home Forward properties do not have building-wide internet access, and residents only sporadically have personal wifi within their units.

The initial goal was to place at least two UbiBot sensors on each residential story (floor) of the high-rise towers HWE and NWT. PV consists of 15 single-story buildings and one two-story building. There, the goal was to achieve a distribution of sensors across the property (lot), including at least one second-story unit. In all cases, the ideal was to place sensors far apart to capture a greater range of conditions (e.g., on opposite ends of a hallway rather than in neighboring units). Practical placement was determined by the number and location of residents who offered to participate. In some cases at HWE and NWT, a particular story was covered by only one sensor, or not covered at all.

Property Name	Stories with 2 Sensors	Stories with 1 Sensor	Stories with No Sensor	% of Residential Floors Covered
Hollywood East	2nd - 12th, 14th	N/A	13th, 1st (non-res)	92%
Northwest Tower	2nd - 6th, 8th, 10th-12th	Main: 1st, 7th, 13th Annex: 2nd, 3rd	9th, Annex 1st	88%
Peaceful Villa	Single sensors were placed in 5 out of 15 single-story buildings, and in one second-story unit.			

[2] All sensors were installed at PV on June 30, 2022. Sensor installations at NWT and HWE each took place over two days; sensors were installed on June 30th and July 7th, 2022 at NWT, and July 8th and 14th, 2022 at HWE. Data points from the sensor removal day, September 23, were not included in analysis.

Social Survey

The survey was distributed in person to all 53 participating residents in September. The response rate was 92.5% (49 out of 53) with a question completion rate of 100% for multiple choice questions. The exception was question #8, which was not answered by 5 of 49 respondents; there, residents were asked to select symptoms related to heat exposure they had experienced, if any. Survey participants were selected through convenience sampling. Only those individuals who had previously agreed to participate in the study and were already hosting a temperature sensor were included. The survey instrument consisted of two short fill-in questions for self-identification; 15 multiple choice questions, 6 of which included a write-in "other" option; and one short answer question where residents could let Home Forward know of any thoughts, concerns, or suggestions pertinent to heat in the property. The content covered four main topics: demographic information, experiences with indoor heat and heat-related illness, perceptions of heat risk and preparedness, and coping strategies. All survey questions and responses are detailed within the **Results: Survey Data Analysis** section below.

Resident Workshops

The project team hosted two resident workshops as a follow-up to summer temperature and survey data collection. A 3.5-hour workshop, led by a facilitator, was held on site in the 'community room' at both HWE and NWT; each focused specifically on the findings related to that property, not the three-property study as a whole.[3] On-site locations were selected to maximize accessibility and comfort for building residents. All HWE and NWT residents who participated in summer temperature monitoring and surveying were invited to attend the workshop on their property. Workshops took place on January 16th, 2023 with 12 participants, and January 17th, 2023 with 13 participants at HWE and NWT, respectively.

At the beginning of each workshop, participants were given an 'Individual Unit Temperature Profile' handout, showing the results of summer temperature monitoring within their own unit (see example in Appendix A), as well as summary information from the full property. This enabled individuals to comment on what they saw in their own homes – for example, feelings of discrepancy between what they felt and what the temperature sensor recorded, or noticeable decreases in temperature after an air conditioner was installed – and compare single-unit data against building-wide averages. This design was intentional about giving those affected by indoor heat the opportunity to see, respond to, and in some cases explain the data that they helped collect. Other, specific goals laid out for the workshops were as follows:

- Get people more comfortable with one another and feel a sense of community and trust more fully in the room
- Better understand the data findings of the study and explore data through resident experiences
- Identify actions to be taken or information to be shared – by Home Forward and/or the Portland Bureau of Emergency Management – to improve indoor heat conditions
- Identify individual actions and adaptations to improve residents' heat safety awareness and preparedness

The workshops were divided into five components: (1) Introductions of the project team and intentions of the work; (2) Resident self-introductions and sharing of preferred, personal cooling strategies; (3) Presentation of data findings and discussion of those results; (4) Brainstorming activity focused on actions and solutions; (5) Open question-and-answer session with representatives from Home Forward

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[3] No workshop was held at PV due to the small number of original participants from that property (6) and the likelihood that some of those residents would be unable to attend such an event.

and PBEM. In component 3, residents shared how the temperature and survey findings aligned with their personal experiences, and provided deeper information about their cooling strategies and building conditions. This helped to explain otherwise confounding or surface-level study results. For example, residents discussed when and how they used air conditioners over the summer, what measures they took to limit heat exposure indoors (e.g., applying homemade insulation, keeping lights and electronics off), and impressions of how their building radiated heat indoors during the afternoon/evening. Participants were also invited to comment on their impressions of the study and temperature alerts (audio, text message, and/or email) during this segment. In component 4, a facilitator provided residents with the following solutions-oriented prompt: *"What would help you feel safer and better prepared for hot days?"* Responses were organized within five designated categories:

- Actions that can be taken at the building level (ex: central air conditioning, longer cooling center hours)
- Information and communications (ex: heat-related health information, temperature alerts, heat first aid classes)
- Amenities for individual units (ex: shade curtains, window screens)
- Community-building activities (ex: social events, neighbor check-ins on hot days)
- Other

A synthesis of outputs from the two resident workshops is available within the **Results: Workshop Findings** section below.

Data Notes

Of the 53 temperature sensors deployed, four were excluded from final analysis (final n = 49), all on the lower floors of NWT. These included the one sensor placed on the first story and both sensors placed on the third story, resulting in only 75% of floors in NWT (including the Annex) being covered by a sensor, down from 88%. Due to location, building materials, or other, unknown environmental factors, these three sensors were never able to establish a strong cell connection. As a result, they did not reliably record or upload data throughout the summer. Sensors were left in place for the duration of the study so that residents could read current temperature and humidity data on the screen, and residents were still included in the survey and NWT workshop. However, these devices did not generate consistent data for the purpose of temperature analysis. Additionally, one of the two sensors placed on the second story of NWT was excluded from analysis. This sensor did not establish a strong cell connection, and was removed from the unit by the resident at an unknown time mid-study, rendering any data unusable.

Only those few sensors that were constantly offline were removed from the final temperature data analysis. However, many of the remaining sensors went offline from time to time, typically due to a loss of cell connectivity or dead batteries. When a cell signal was temporarily dropped, UbiBot sensors retained data internally and those results were retroactively uploaded to the cloud once connectivity was restored. In the case of dead batteries, no data could be collected or recovered. As a result, some individual-unit temperature profiles show temporary gaps when batteries had died and were awaiting replacement. This affected 22 of 49 sensors (45%) at some point during the three-month temperature study. Of those occurrences 50% occurred in the last one to two weeks of the study period.

Results may have been impacted to some extent by the changing presence of air conditioners (AC) within participating units. During this study, Home Forward began a major AC distribution initiative across all properties, supported by the Portland Clean Energy Fund (PCEF), and some residents obtained an AC by other means. When temperature monitoring of the assessed 49 units began, 20 units had a portable AC and 29 did not. By the end of the study, 16 residents had gained an AC and one unit had lost theirs, resulting in a total of 35 with and 14 without air conditioning. When possible, temperature sensors were placed in a separate room or far away from ACs – for example, in the living room if the AC was closed in a bedroom; or in the entryway for studio units, where windows and AC were typically on the opposite side of the space. The presence of ACs, including their location relative to temperature sensors, was tracked and noted by the project team during sensor installation and removal. Details on which units had AC is available in the **Results: Temperature Data Analysis** section below, under *Analysis 5: Temperature by Unit Characteristics*.

Results:

Temperature Data Analysis

Analysis 1: Summary Statistics

The *Sensor Data Summary* table below provides summary statistics for the 49 sensors that were analyzed for this report. This includes the mean, median and mode[4] temperatures recorded by each sensor throughout the three-month study period; the minimum and maximum temperatures recorded by each sensor; and the number of days that each sensor logged a temperature of at least 80, 85, and 90°F. These are the temperature thresholds at which indoor conditions are considered potentially unsafe, and alerts to residents were triggered when any of these thresholds was passed during the study period.

Sensor Data Summary

Property	Sensor #	Mean	Minimum Temperature	Maximum Temperature	Standard Deviation	Median	Mode	Days over 80°F	Days over 85°F	Days over 90°F
HWE	53	74.8	67.9	84.3	3.6	73.7	72.9	9	0	0
HWE	52	76.1	70.2	87.7	3	75.3	74.6	9	4	0
HWE	51	80.2	75.3	87.6	1.7	79.8	79.7	62	4	0
HWE	50	79.2	75.2	86.9	2.4	78.7	77.9	23	5	0
HWE	49	79.1	74.9	85.6	2	79	79.1	28	2	0
HWE	48	79.8	73.3	87.2	2.2	79.5	79.6	46	5	0
HWE	47	76.3	70	82.2	2	75.8	75.4	9	0	0
HWE	46	76.5	71.9	82	1.5	76.1	75.9	9	0	0
HWE	45	76.8	69.8	90	3.9	75.5	74.5	13	5	0
HWE	44	78	70.5	86.8	2.6	77.9	76.8	39	5	0
HWE	43	79.9	72.9	88.9	2.8	79.5	78.9	51	8	0
HWE	42	77.5	72.3	88.1	3.4	76.6	75.9	23	6	0
HWE	41	77.8	69.6	89.2	3.6	77.2	78.2	23	7	0
HWE	40	80.7	76.9	86.9	1.9	80.4	80.4	42	5	0
HWE	39	76.8	70.1	85.6	2.6	76.6	75.1	17	1	0
HWE	38	76.6	69	91.9	3.8	75.8	73	21	9	3
HWE	37	80.1	72.2	89.8	2.2	79.7	77.6	53	10	0
HWE	36	77.1	72	87.3	2.5	76.6	75.2	11	4	0
HWE	35	79.9	74.8	87.3	2	79.9	79	61	7	0
HWE	34	76.4	70.2	82.2	1.6	76.2	75.7	10	0	0
HWE	33	77.3	69.4	85.4	1.9	77	76.9	22	1	0
HWE	32	78.8	71.3	85.7	2.4	78.6	78.2	32	4	0
HWE	31	78.7	74.5	86.5	1.8	78.5	78.4	25	4	0
HWE	30	77.8	67.8	91.3	3.8	78.3	80.5	31	6	2

Table continued on next page

[4] The mean is found by adding together all numbers in a data set and then dividing by the number of values in the set; for example (4+6+2) / 3 values = 12 / 3 = mean of 4. The mean can also be referred to as the 'average.' The median is the middle value when the numbers in a data set are ordered from smallest to largest. The mode is the number that occurs most often in a data set.

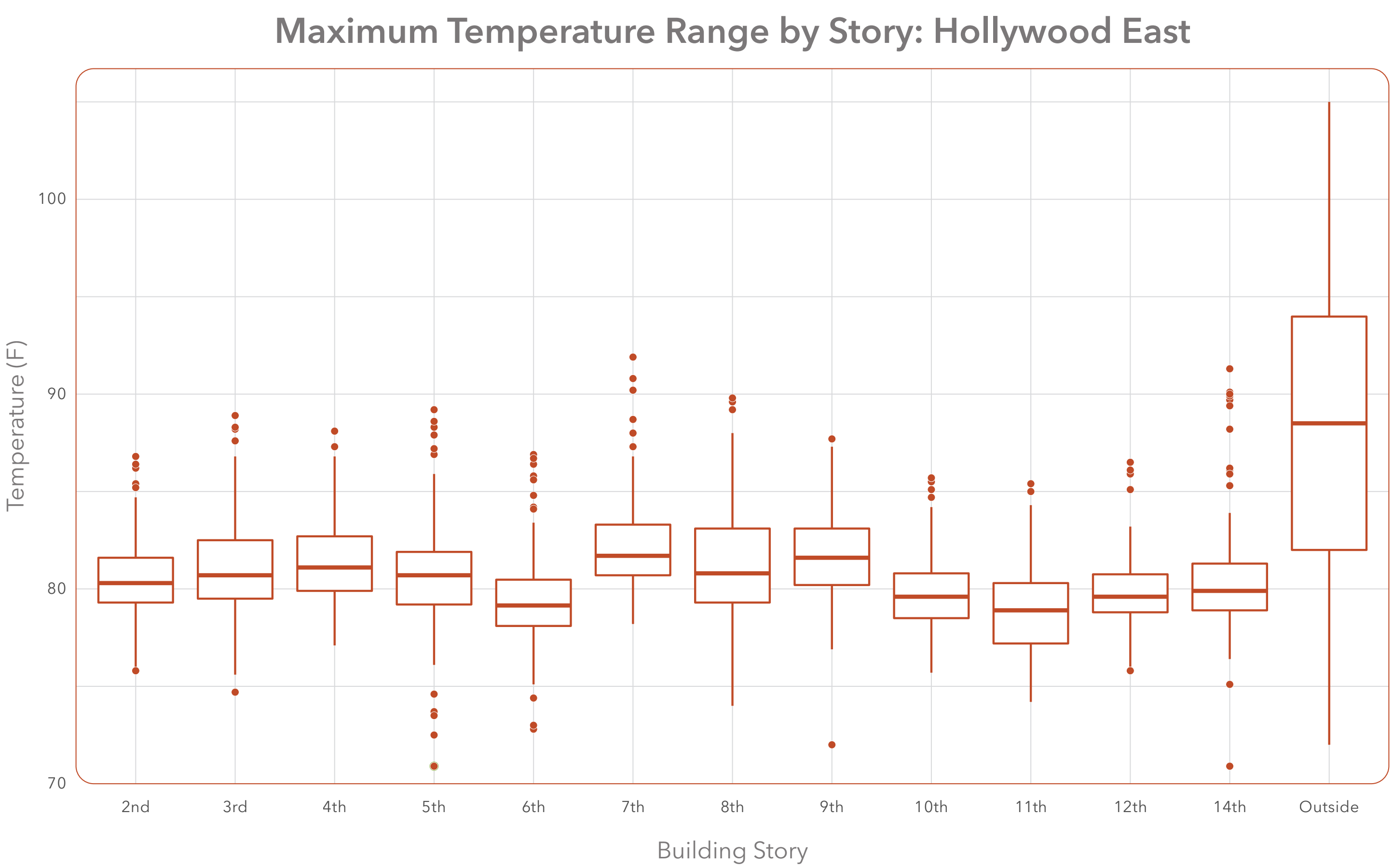
Property	Sensor #	Mean	Minimum Temperature	Maximum Temperature	Standard Deviation	Median	Mode	Days over 80°F	Days over 85°F	Days over 90°F
NWT	29	80.1	68.5	92.8	4.2	79.7	82	53	20	6
NWT	28	77.6	71.7	84.8	1.7	77.3	76.8	33	0	0
NWT	27	79.8	75	88	2.7	79.2	79.5	34	8	0
NWT	25	79.4	72.6	87.6	3.4	78.8	79.5	22	8	0
NWT	21	77.3	69.2	89.8	3.4	76.4	77.3	27	11	0
NWT	20	81.2	75.2	96.5	3.3	80.1	80	57	17	5
NWT	19	78.1	71.5	86.8	2.7	77.9	79.3	32	4	0
NWT	18	80.6	73.6	90.9	2.7	80.7	80.7	62	10	3
NWT	17	79.4	70.8	87.8	2.6	79.4	80.8	66	10	0
NWT	16	73.2	64	92.2	5.5	70.8	70	20	10	2
NWT	15	77.8	68.3	89.3	3.5	77.9	78.9	48	8	0
NWT	14	77.2	67.2	88.9	3.7	76.7	77.9	40	10	0
NWT	13	79.8	72	91.8	2.9	79.9	80.9	72	22	5
NWT	12	79.2	71.4	90.7	3.1	78.5	77.4	44	12	1
NWT	11	71.4	65.9	82.8	3.2	70.6	70.2	6	0	0
NWT	10	75.5	62.4	91.4	4.4	76.2	77.9	46	16	2
NWT	9	79.8	73.7	90	2.8	79.5	80.7	61	10	0
NWT	8	78.7	74.1	84.5	1.4	78.8	77.1	44	0	0
NWT	7	77.7	69.7	88	2.2	77.6	77.1	48	6	0
PV	6	76.1	66	87.9	2	76.1	74.3	22	4	0
PV	5	80.1	72.1	86	1.5	80.2	78.3	74	3	0
PV	4	76.6	69.1	85.6	2.5	76.5	73.7	26	1	0
PV	3	76.5	68	80.7	1.3	76.7	76.4	5	0	0
PV	2	78	69.9	84.7	1.4	77.9	77.9	56	0	0
PV	1	75.5	68.1	86.5	2.6	75.4	73.9	19	3	0

Mean and median temperatures were consistently at or below 80°F across sensors, likely due to the inclusion of lower overnight temperatures in those calculations. The result does not imply that units remained cool at all times of day. Every participating unit (100%) reached over 80°F on multiple days; 40 of 49 (82%) reached 85°F at least once, and 9 of 49 (18%) reached over 90°F. NWT had the highest number of days over 90°F, which suggests a need to further study this building.

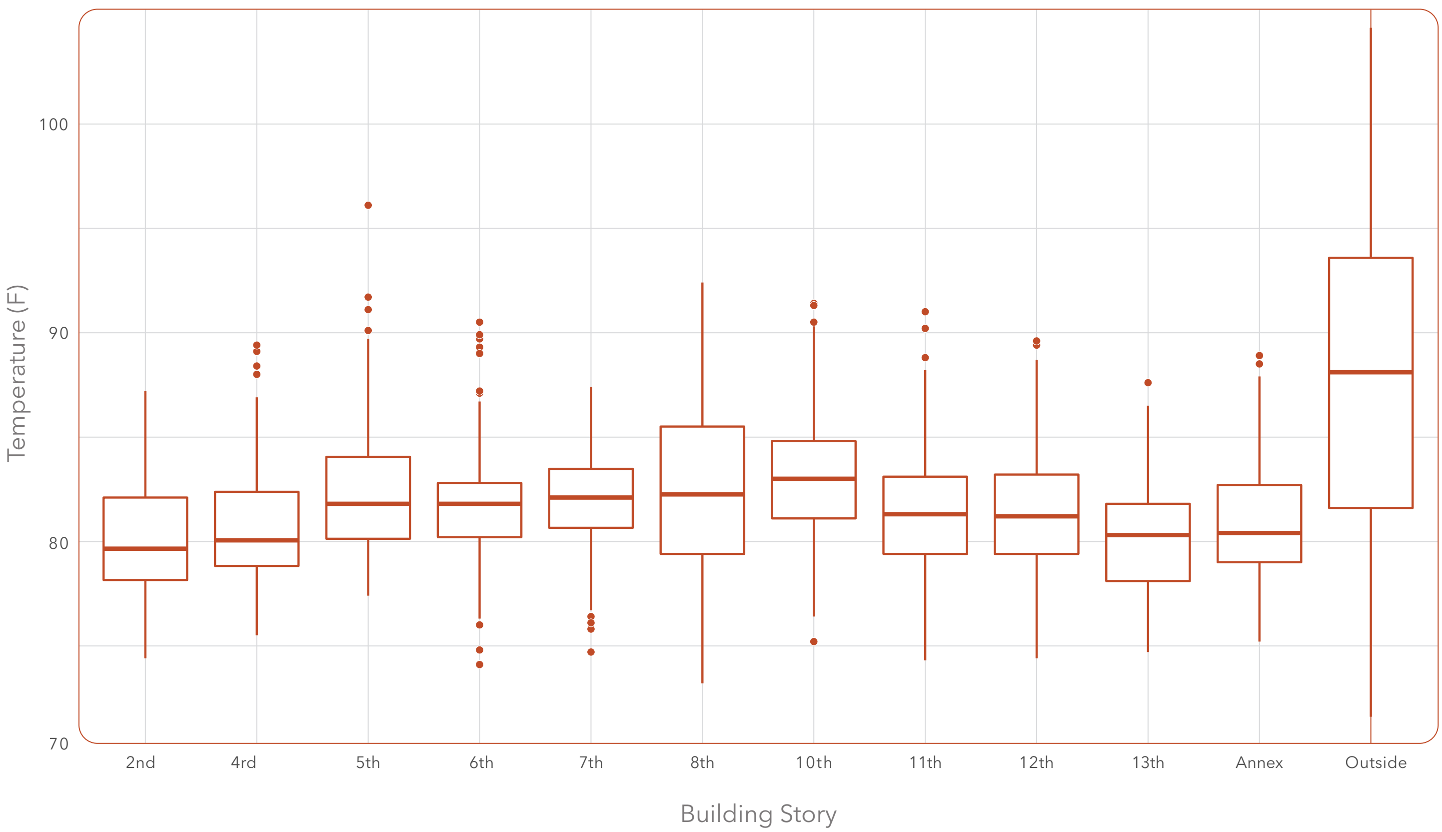
A total of eight units logged fewer than a dozen days over 80°F, delineating them as some of the coolest in the study. Among those, seven had AC consistently throughout the study period and one installed an AC during the study. In two of those units (one at PV and one at NWT), the AC was located in a separate bedroom, away from the sensor which was placed in the living room. This suggests that those residents were utilizing other, non-AC cooling measures near the sensor and/or perhaps that the AC was effectively cooling multiple rooms. The remaining six units were studio apartments with sensors placed in the entryway, as far away from the AC as possible, but technically in a contiguous space. Findings from those units suggest that the ACs in use may have been powerful enough to affect the full area of the unit, and/or that residents were supplementing AC with other cooling measures. Subsequent analysis revealed no significant, widespread difference between mean maximum temperatures in units with and without AC, so the lower temperatures in these eight units appear anomalous. More detail on AC status and effects can be found in *Analysis 5*.

Analysis 2: Maximum Temperature Range

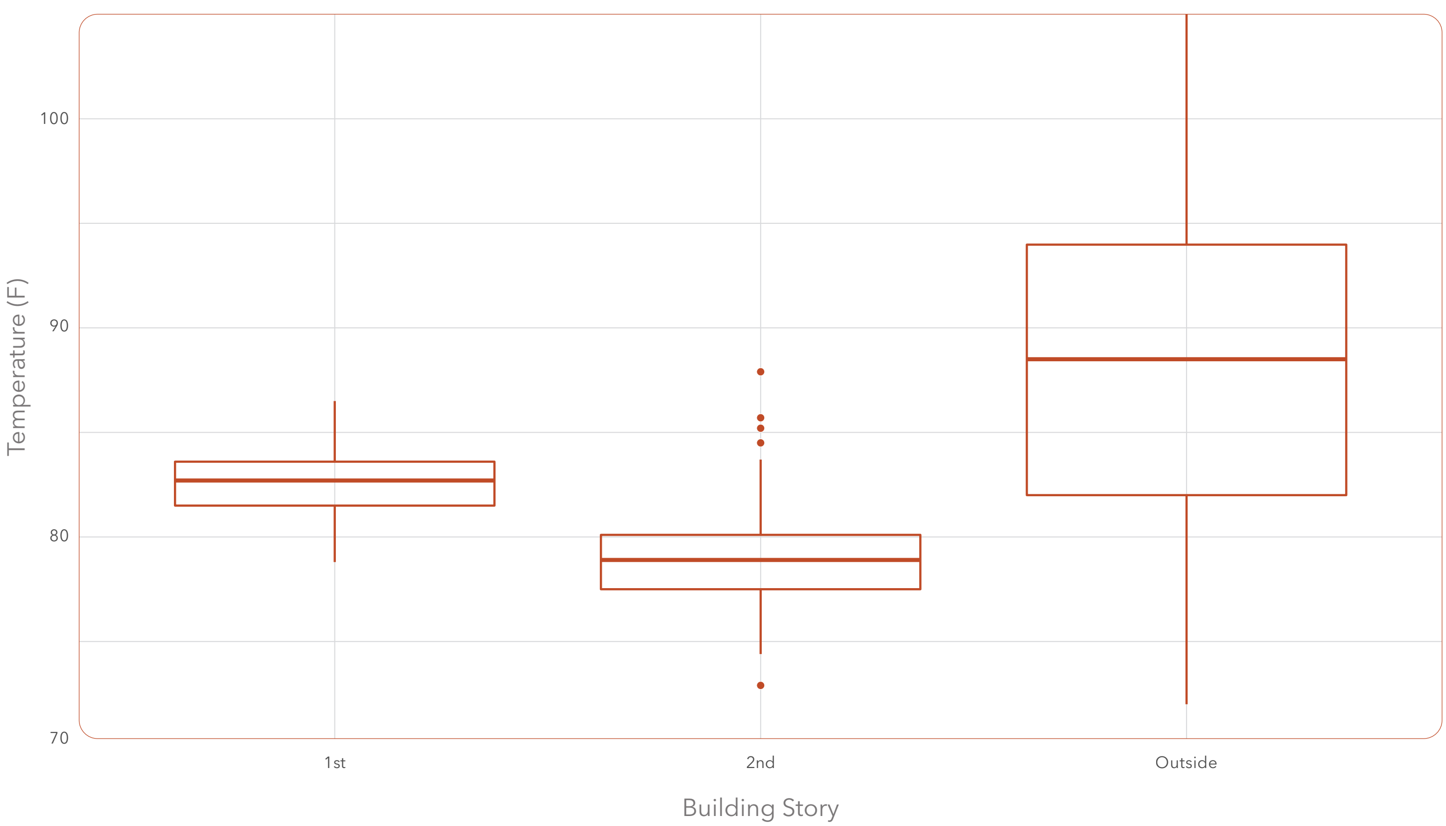
The following three figures – *Maximum Temperature Range by Story: Hollywood East, Northwest Tower and Peaceful Villa* – show the range of maximum temperatures recorded on each story of each property. Each range (box and whisker) captures the absolute maximum record from each story, from every day of the study period. For example, sensors on the 5th story of NWT logged temperatures on 78 days; the 5th story range shown for NWT reflects the 78 daily maximum temperatures recorded on that story. Boxes and lines cover the normal range for the dataset while dots represent outliers. Note that these only contain temperature ranges for stories which had at least one temperature sensor in place. The 2nd and 3rd stories of the NWT Annex have been combined into one box and whisker. Each figure also contains a range labeled "Outside." This reflects the range of daily maximum outdoor temperatures in the Portland region during the study period. Outdoor measurements were acquired from quality controlled sensors, used by the National Weather Service, and were obtained through Synoptic (https://synopticdata.com/) via their Mesonet API. The fourth figure shown below – *Maximum Temperature Range by Property* – offers a comparison of building-wide maximum temperature ranges and outdoor conditions.

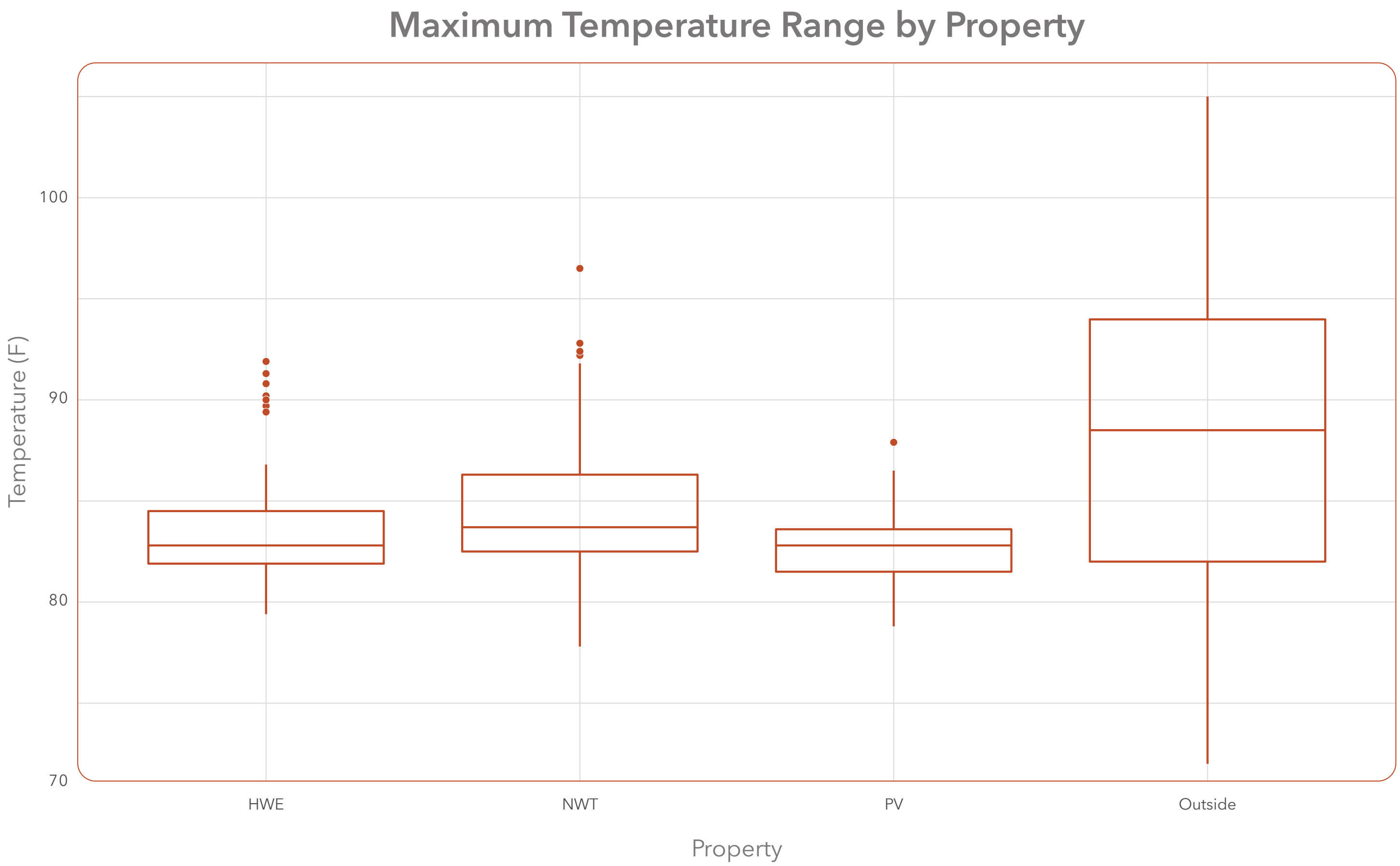


Maximum Temperature Range by Story: Northwest Tower



Maximum Temperature Range by Story: Peaceful Villa





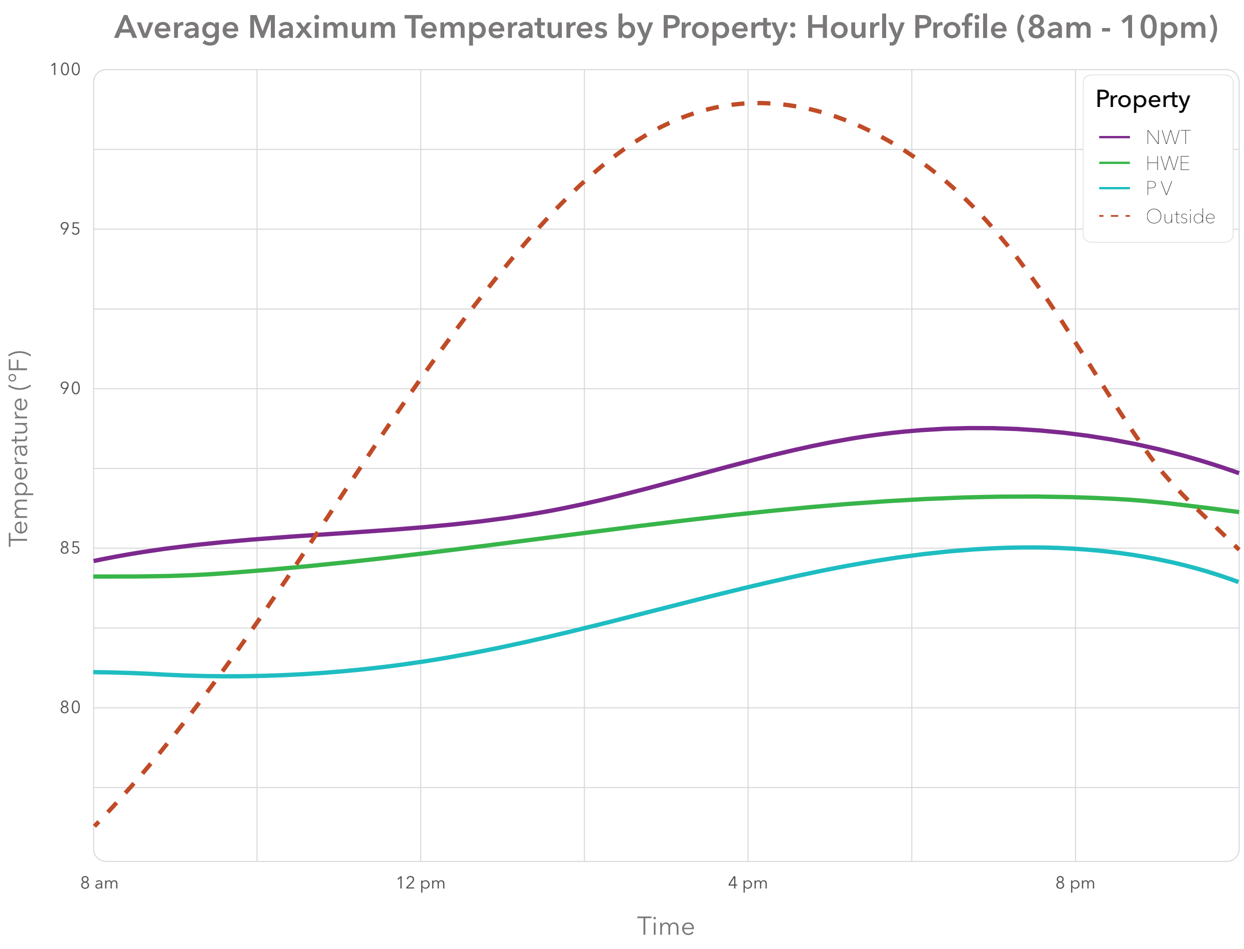
The analysis suggests that maximum outdoor temperatures covered a larger range than any indoor temperatures, either at the individual story or building-wide scale. Although outdoor temperatures exceeded 100°F on multiple occasions, indoor temperatures typically maxed out in the low to mid 90s at HWE and NWT, and in the high 80s for PV. Notably, the lowest outdoor maximums were cooler than the lowest indoor maximums for all three properties. With only a few exceptions (NWT Annex 3rd story, HWE 5th and 14th stories), this finding also held for individual stories. This shows that even on relatively cool outdoor days (maximum temperatures under 75°F), maximum indoor temperatures were still reaching into the upper 70s or higher on most stories.

There is no obvious relationship present between maximum temperature range and building story. It is typically assumed that higher stories will be hotter than lower stories, particularly in high-rise properties like HWE and NWT. The highest temperatures were actually reached on the 8th and 10th stories of NWT, which repeatedly went over 90°F, while outliers over 90°F were recorded on the 5th, 6th, and 11th stories. The uppermost story in that building (13th) unexpectedly showed the lowest maximum temperature when not accounting for outliers. In HWE, the 3rd, 4th, 7th, 8th and 9th stories showed the hottest normal ranges, while the uppermost story (14th) had high outliers but a comparatively low normal range.

Differences in the presence of AC could at least partially account for lower temperatures on upper floors given that all sensors on NWT 13th story and HWE 14th story shared space with an AC for some portion of the study period. The outliers present on the 14th story of HWE may be a more accurate representation of maximum temperatures when, presumably, an AC was not running. However, those high values did not differ significantly from values recorded on the 7th story of HWE, where both participating units had an AC located away from the sensor (i.e., not influencing temperature readings as strongly). There is seemingly potential for a middle story to get as hot as the uppermost story in HWE when AC use is not a factor.

Analysis 3: Hourly Temperature Profile

Temperature changes throughout the day are shown in the figure titled *Average Maximum Temperatures by Property: Hourly Profile (8am-10pm)*. There is a line representing temperature change for each of the three properties, and a line representing outside conditions over the same period. These lines are based on the average maximum temperatures recorded in each property at each hour of the day, from 8am-10pm. To calculate these values, the maximum temperatures logged by every sensor in a property at each hour were averaged. For example, sensor #1 recorded data at Peaceful Villa on 85 days, so there are 85 readings at 5pm for that sensor. The maximum temperature among those 85 values was 84.5°F. This same calculation was done for all sensors at PV (#1-6). Those 6 maximum values were then averaged to get the property-wide average maximum temperature for the 5pm hour, which is reflected in the Hourly Profile figure below. A complete summary of maximum hourly temperature recordings for each sensor, used to create this figure, is provided in the table titled *Maximum Hourly Temperature by Sensor* (Appendix B).



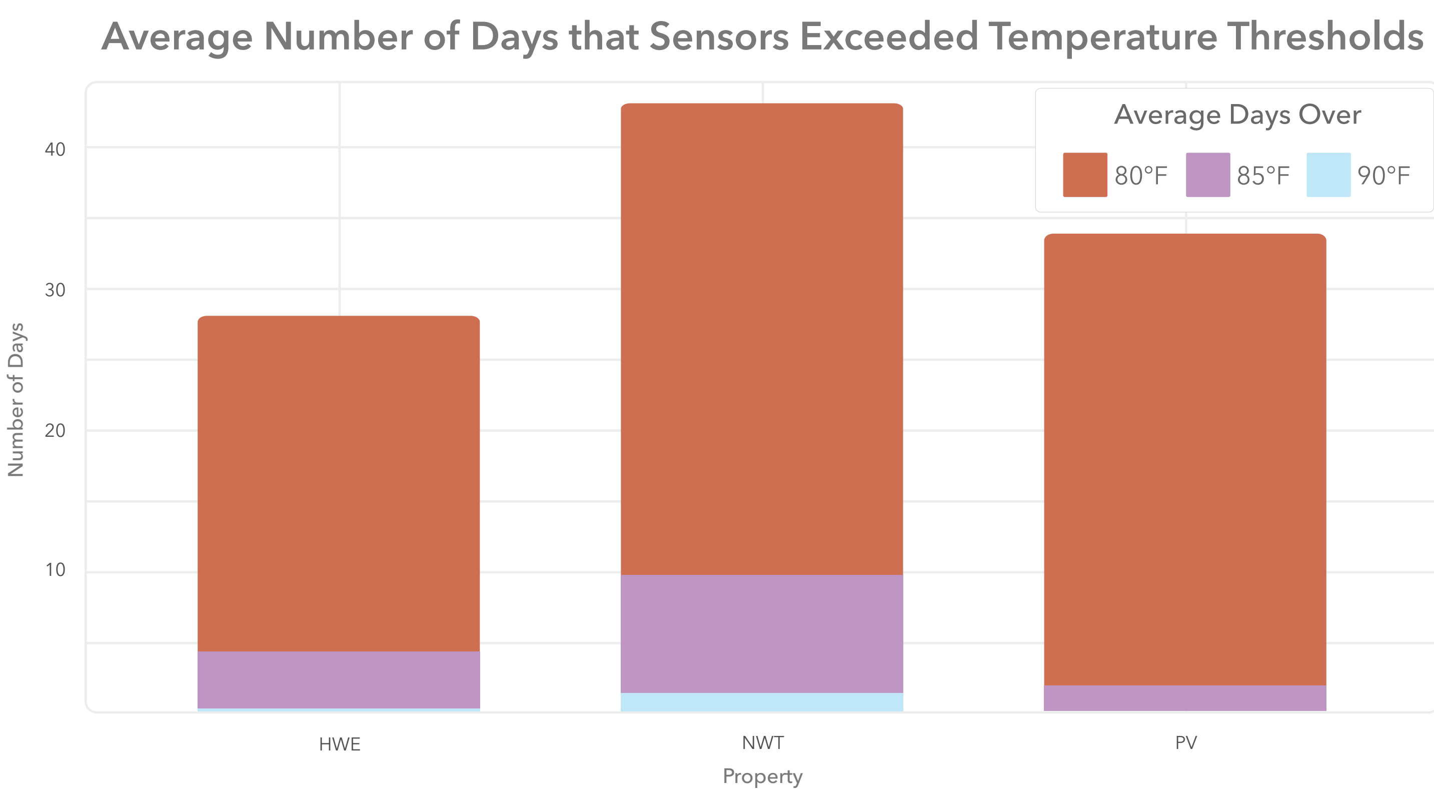
Although outdoor temperatures peaked at 4pm on average, indoor temperatures did not peak until around 6-7pm for NWT, and 7-8pm for HWE and PV. This finding is consistent with results from the survey detailed in the next section, where multiple residents noted high temperatures into the evening. On-site cooling centers are open during the hottest part of the day outdoors, though current operating hours do not correspond with hottest times of day indoors for these three properties. [5] The figure further illustrates that indoor temperatures in all properties begin to decline after 8pm and begin to rise between 8-10am.

[5] On-site cooling centers at NWT and HWE open for 24 hours per day when the National Weather Service issues a heat warning. On a typical hot day (i.e., not an extreme heat wave), cooling centers are only open during business hours, though indoor temperatures remain high into the night. At PV, the on-site cooling center is not open 24 hours in any weather conditions due to the unsecured nature of the community space on that property.

Analysis 4: Temperature Threshold Exceedances

All units across the three Home Forward properties reached at least 80°F on numerous occasions, while fewer units reached over 85 or 90°F (see the *Sensor Data Summary* table at the beginning of this section for a detailed breakdown by sensor). Differences were evident across properties in the number of days on which those higher thresholds (85+ or 90+°F) were reached.

The six sensors at PV recorded data for 85 days, and recorded temperatures of 80+°F on an average of 33.7 days, or 39.6% of days in the study period. The 19 sensors at NWT recorded data for either 75 or 85 days, and recorded temperatures of 80+°F on an average of 42.9 days, or 50.4-55% of days in the study period. The 24 sensors at HWE recorded data for either 77 or 71 days, and recorded temperatures over 80°F on an average of 27.9 days, or 36.2-39.3% of days in the study period. Participating units in NWT experienced the largest raw number of days over 80, 85, and 90°F compared to the other two properties, as well as the greatest proportion of high heat days at all three thresholds. Units in HWE and PV had similar proportions of days over 80°F (around 40%), but units in HWE were more likely to get hotter (85+°F) than those in PV. While units at PV recorded no days over 90°F, participating units in NWT and HWE reached over 90°F on an average of 1.3 and 0.2 days, respectively, during the study period. These differences may be at least partially attributable to the high-rise structure and concrete building material of NWT and HWE, compared to the lower-profile and wooden structures of PV. Per survey findings, some high-rise residents reported feeling heat coming off of interior concrete walls, suggesting that these buildings easily absorbed heat during the day.



Property	Avg days over 80	Avg days over 85	Avg days over 90
HWE	27.9	4.2	0.2
NWT	42.9	9.6	1.3
PV	33.7	1.8	0

Analysis 5: Temperature by Unit Characteristics

There were uncontrolled variables which may have impacted indoor temperatures throughout this study. Anything pertaining to residents' behavior would have been outside of researchers' knowledge; for example, cooking on a hot day, leaving doors and windows open, or taking a hot shower. Three unit characteristics which were known and which may have influenced temperature data are the presence of residential air conditioning; the direction that windows faced (north, east, south, or west); and the availability of tree shade. For the purpose of this analysis, a unit was considered to have tree shade if there was a tree immediately outside of a window in the same room as the temperature sensor. Window direction was based on the placement of windows closest to the sensor. In HWE and NWT, all units had windows which faced only one direction, while some units in PV had windows on either side of the building. *The Full Unit Characteristics* table shows a breakdown of these characteristics by sensor. The column "Shared Space for AC & Sensor" indicates whether a sensor and AC were in the same room. In studio units, sensors placed in the entry hallway were not categorized as "in a shared space" if an AC was located in the main room.

Full Unit Characteristics						
Property	**Story**	**Sensor #**	**AC Status**	**Shared Space for AC & Sensor**	**Tree Shade**	**Window Direction**
HWE	2nd	49	No AC	N/A	Tree Shade	W
HWE	2nd	44	No AC	N/A	No tree shade	S
HWE	3rd	47	AC consistent	No	No tree shade	E
HWE	3rd	43	No AC	N/A	No tree shade	S
HWE	4th	42	AC change	Yes	No tree shade	W
HWE	4th	48	No AC	N/A	No tree shade	N
HWE	5th	40	No AC	N/A	No tree shade	N
HWE	5th	41	AC change	No	No tree shade	S
HWE	6th	39	No AC	N/A	No tree shade	N
HWE	6th	50	No AC	N/A	No tree shade	N
HWE	7th	51	AC consistent	No	No tree shade	E
HWE	7th	38	AC change	No	No tree shade	N
HWE	8th	36	AC consistent	No	No tree shade	E
HWE	8th	37	AC consistent	No	No tree shade	S
HWE	9th	52	AC consistent	No	No tree shade	E
HWE	9th	35	No AC	N/A	No tree shade	S
HWE	10th	32	AC change	Yes	No tree shade	E
HWE	10th	34	AC change	No	No tree shade	S
HWE	11th	53	AC consistent	No	No tree shade	N
HWE	11th	33	AC consistent	No	No tree shade	N
HWE	12th	46	AC consistent	No	No tree shade	N
HWE	12th	31	AC change	No	No tree shade	N

Table continued on next page

Property	Story	Sensor #	AC Status	Shared Space for AC & Sensor	Tree Shade	Window Direction
HWE	14th	45	AC change	Yes	No tree shade	W
HWE	14th	30	AC consistent	Yes	No tree shade	N
NWT	2nd	25	AC change	No	No tree shade	W
NWT	Annex 2nd	15	AC change	Yes	No tree shade	W
NWT	4th	21	No AC	N/A	Tree Shade	E
NWT	4th	28	AC change	No	Tree Shade	W
NWT	Annex 3rd	14	AC consistent	No	No tree shade	E
NWT	5th	19	No AC	N/A	No tree shade	W
NWT	5th	20	AC change	No	No tree shade	E
NWT	6th	27	AC consistent	No	No tree shade	E
NWT	6th	18	AC change	No	No tree shade	W
NWT	7th	17	AC consistent	No	No tree shade	W
NWT	8th	16	AC change	Yes	No tree shade	W
NWT	8th	29	No AC	N/A	No tree shade	E
NWT	10th	13	No AC	N/A	No tree shade	W
NWT	10th	12	AC consistent	No	No tree shade	E
NWT	11th	11	AC consistent	No	No tree shade	E
NWT	11th	10	AC consistent	Yes	No tree shade	W
NWT	12th	8	AC change	Yes	No tree shade	E
NWT	12th	9	AC change	No	No tree shade	W
NWT	13th	7	AC change	Yes	No tree shade	W
PV	1st	1	AC change	No	Tree Shade	N
PV	1st	2	AC consistent	Yes	No tree shade	S
PV	1st	3	AC consistent	No	Tree Shade	S
PV	1st	4	No AC	N/A	Tree Shade	W
PV	1st	5	AC consistent	Yes	No tree shade	E
PV	2nd	6	AC consistent	No	No tree shade	S

It was not possible to determine the exact impact of these various characteristics on indoor temperatures due to a small sample size, and the fact that there are no controls against which to compare the results. However, by comparing participating units against those with different characteristics, some possible relationships are revealed. Those findings are detailed in the table *Average Maximum Temperature by Unit Characteristics* below, which shows mean maximum temperatures averaged by story. In fact, results show little variation between units with and without tree shade, with windows facing different directions, and with and without air conditioning. As a reminder, many air conditioners were not located in the same room as temperature sensors, so this latter result was somewhat predictable. This result does not necessarily suggest that AC cannot effectively cool limited spaces (i.e., a single room with the door closed). It is also possible that AC could be effective but is not being consistently used by residents (i.e., an AC is technically present in the unit but is not turned on). Further insight into when and how residents use AC are presented in the **Results: Workshop Findings** section.

The notable outlier and lowest temperature (73.1°F) in this table can be found on the 11th story of NWT. This value comes from a unit which had an AC in a different space than the sensor, no tree shade, and east-facing windows. 56% of values in the table are at or above 80°F with no clear relationship to unit characteristics.

Maximum Temperature by Unit Characteristics									
Story	AC Consistent	No AC	AC Change	Tree Shade	No Tree Shade	Window Direction			
						North	South	East	West
HWE	**79**	**80.8**	**79.4**	**79.9**	**79.6**	**79.7**	**80.4**	**79.1**	**79.4**
2nd	N/A	80	N/A	79.9	80	N/A	80	N/A	79.9
3rd	77.7	81.1	N/A	N/A	79.5	N/A	81.1	77.7	N/A
4th	N/A	81.1	78.9	N/A	80	81.1	N/A	N/A	78.9
5th	N/A	81.4	79.5	N/A	80.3	81.4	79.5	N/A	N/A
6th	N/A	79.1	N/A	N/A	79.1	79.1	N/A	N/A	N/A
7th	82	N/A	79.4	N/A	80.7	79.4	N/A	82	N/A
8th	80.1	N/A	N/A	N/A	80.1	N/A	81.8	78.5	N/A
9th	77.8	81.9	N/A	N/A	80	N/A	81.9	77.8	N/A
10th	N/A	N/A	79	N/A	79	N/A	78.3	79.8	N/A
11th	77.7	N/A	N/A	N/A	77.7	77.7	N/A	N/A	N/A
12th	78	N/A	80.1	N/A	79	79	N/A	N/A	N/A
14th	80.1	N/A	79.4	N/A	79.8	80.1	N/A	N/A	79.4
NWT	**80.2**	**81.5**	**80.6**	**80.3**	**80.6**	**N/A**	**N/A**	**80.1**	**80.8**
2nd	N/A	N/A	80.8	N/A	80.8	N/A	N/A	N/A	80.8
4th	N/A	80.8	80	80.3	N/A	N/A	N/A	80.8	80
5th	N/A	79.8	82.8	N/A	81.3	N/A	N/A	82.8	79.8
6th	80.8	N/A	82.2	N/A	81.5	N/A	N/A	80.8	82.2
7th	82.4	N/A	N/A	N/A	82.4	N/A	N/A	N/A	82.4
8th	N/A	82.4	76.8	N/A	79.9	N/A	N/A	82.4	76.8
10th	81	83.2	N/A	N/A	82.1	N/A	N/A	81	83.2
11th	76.8	N/A	N/A	N/A	76.8	N/A	N/A	73.1	80.4
12th	N/A	N/A	81.1	N/A	81.1	N/A	N/A	80.4	81.8
13th	N/A	N/A	80.6	N/A	80.6	N/A	N/A	N/A	80.6
Annex 2nd	N/A	N/A	80.7	N/A	80.7	N/A	N/A	N/A	80.7
Annex 3rd	80	N/A	N/A	N/A	80	N/A	N/A	80	N/A
PV	**79.8**	**78.9**	**78.4**	**78.5**	**80.4**	**78.4**	**79.3**	**82.2**	**78.9**
1st	80.4	78.9	78.4	78.5	81.6	78.4	79.5	82.2	78.9
2nd	79.1	N/A	N/A	N/A	79.1	N/A	79.1	N/A	N/A

The values in this table are based on the average of maximum daily temperatures for each sensor. This value was calculated for each sensor by averaging together all of its daily maximum recordings. For example, sensor #6 logged data at PV on 85 days, so there are 85 daily maximum temperature readings for that sensor. The average of those 85 values was calculated to generate the temperature used in this table (79.1°F). When a story had only one sensor featuring a particular characteristic, the average of each day's maximum temperature for that one sensor is reflected in the corresponding cell of the table. For example, the 3rd story of HWE had only one sensor (#47) classified as "AC Consistent" and one sensor (#43) classified as "No AC." Therefore, the value in the "AC Consistent" cell for the 3rd story of HWE reflects the average of daily maximum temperatures just for sensor #47; the value in the "No AC" cell reflects the average of daily maximum temperatures just for sensor #43; and the cell for "AC Change" in that row shows "N/A" because no sensors on that story featured that characteristic. In cases where two sensors on the same story fell into the same characteristic category, the two 'average of maximum' values were averaged with each other. This was the case, for example, with the 6th story of HWE, where both sensors had "No AC." Property-wide averages for HWE, NWT and PV are also reflected in this table.

Results:

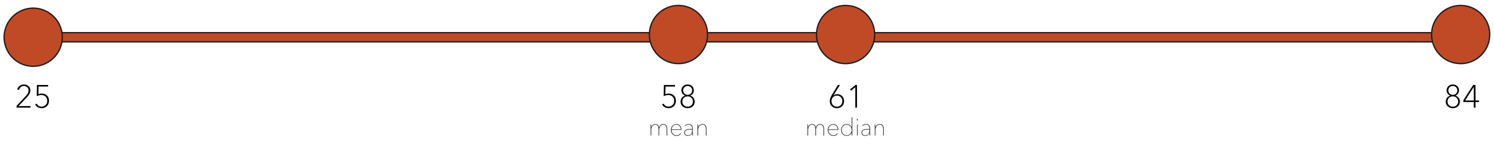
Survey Data Analysis

This section contains results from the 49 surveys received by the project team. Survey question 1 asked for the resident's unit number and is excluded from this report. All other survey questions are reproduced below and responses are represented in graphical and/or written form as appropriate.

Question 2

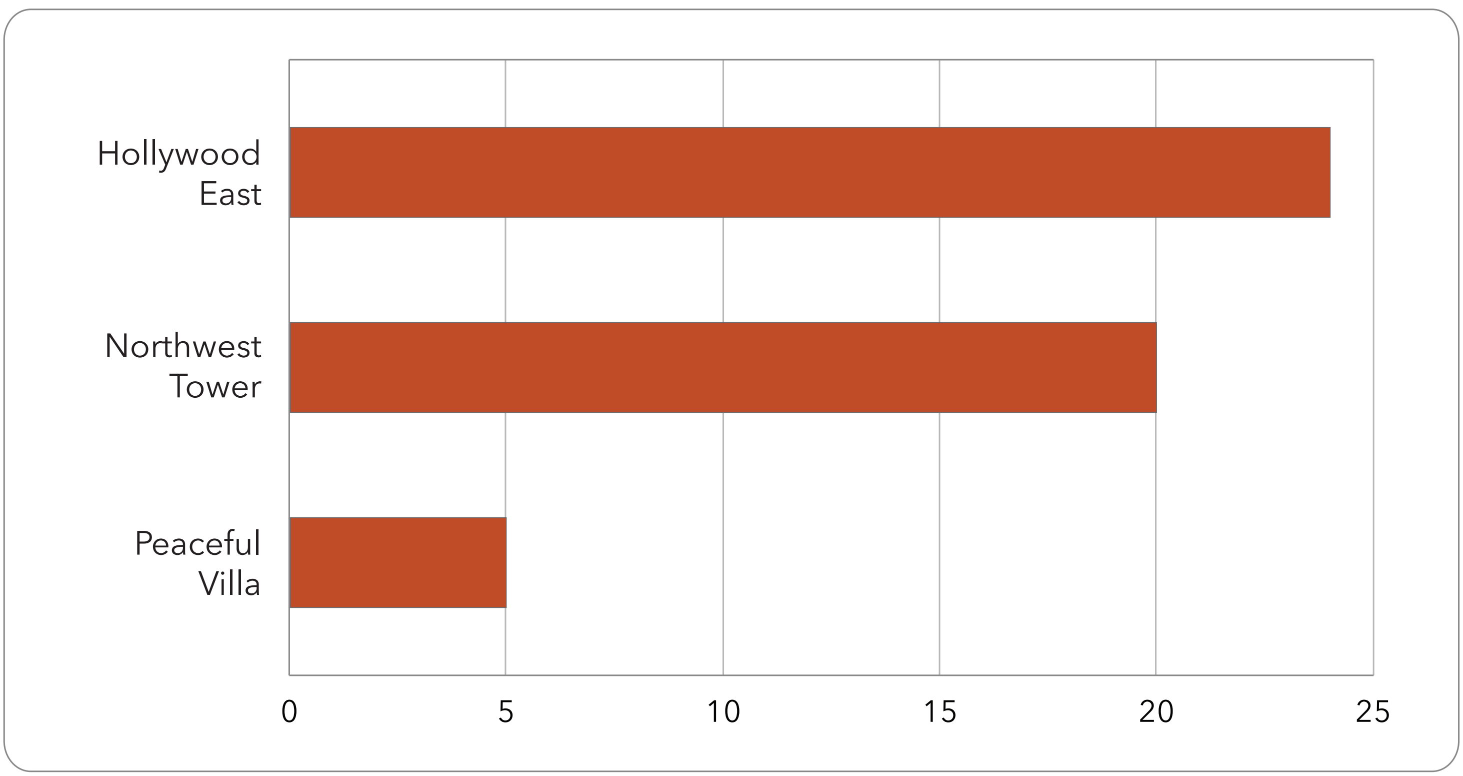
Resident's Age

Responses ranged from 25 to 84 years old. The median age of respondents was 61 years old, and the mean age was 58 years old.



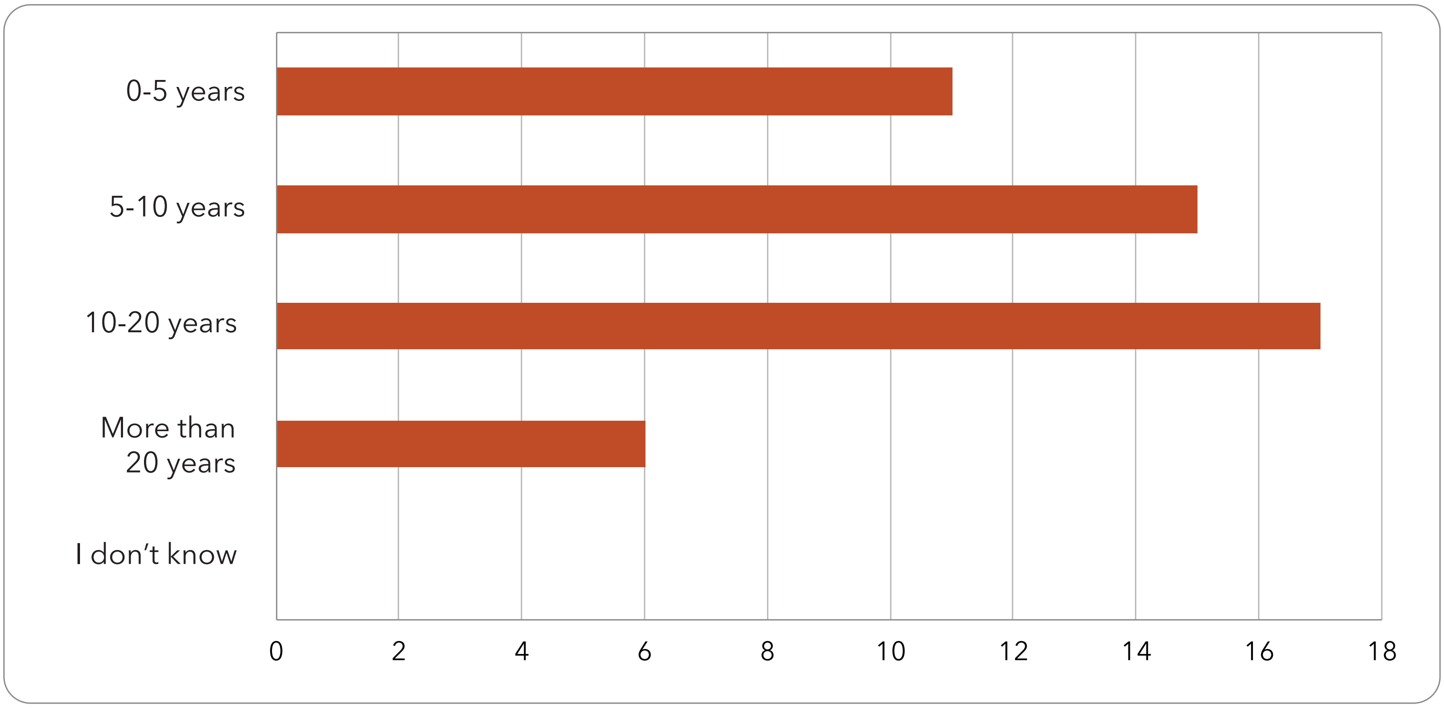
Question 3

In which property are you currently living?



Question 4

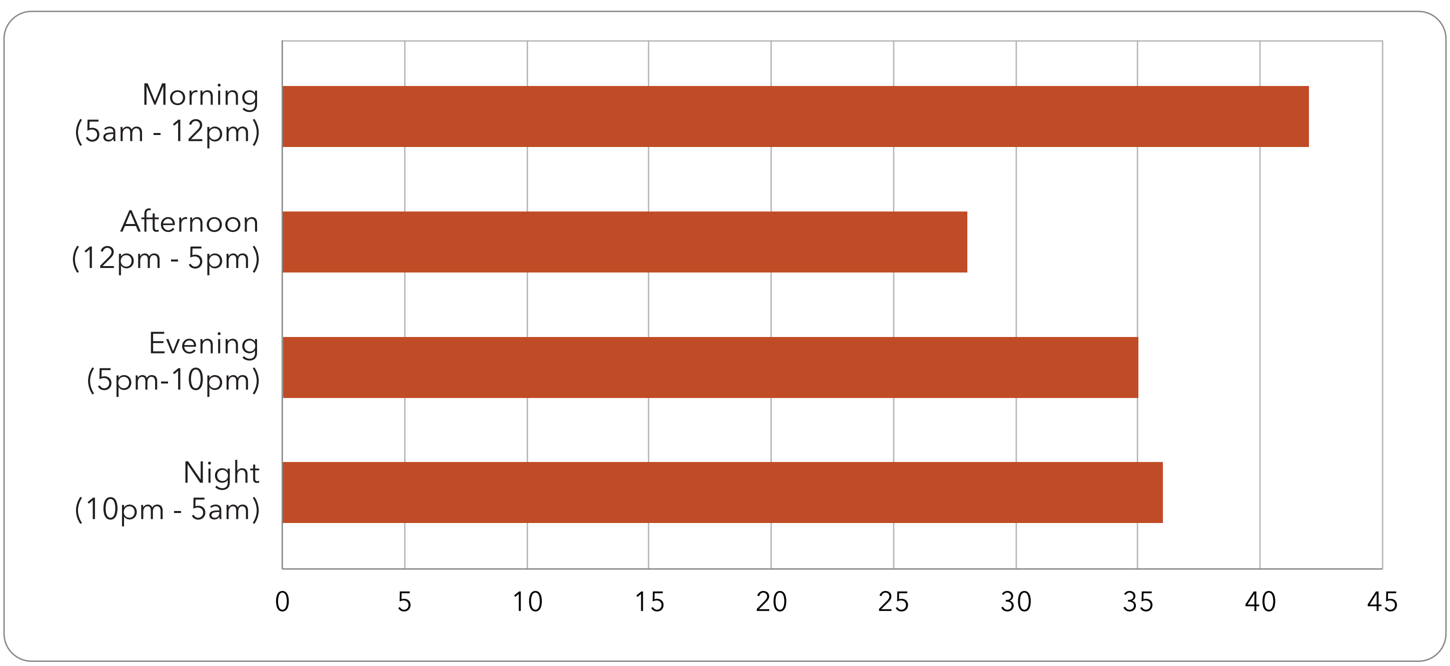
How long have you lived in this property?



Question 5

At what times of day are you usually at home?

(select all that apply)

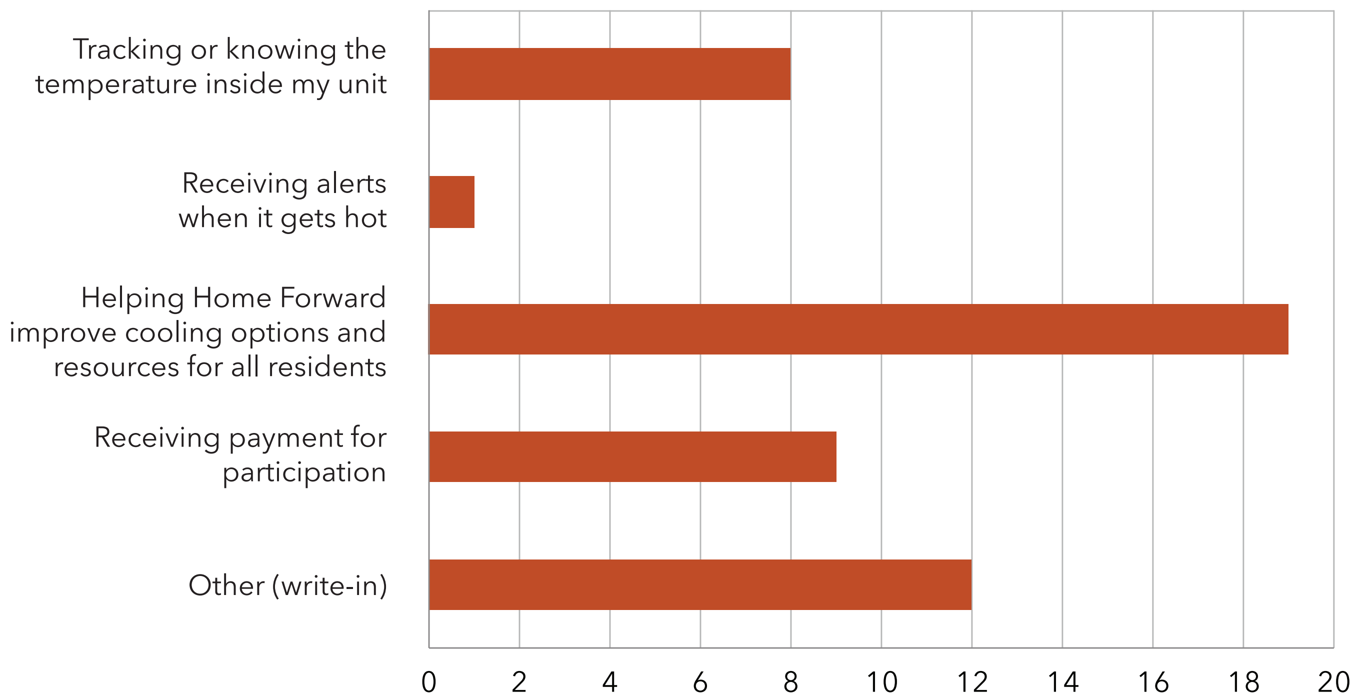


Twenty-four residents (49%) indicated that they are typically home at all times of day listed.

Question 6

Why did you decide to participate in this study?

(select ONE benefit that was most important to you)



Residents who listed more than one reason for participating were recorded as having given a response of "other," as were those who did write in an alternative response. For example, if a respondent selected two answers, the response was recorded as "Other: Resident selected two: Tracking temperature AND Helping Home Forward improve cooling."

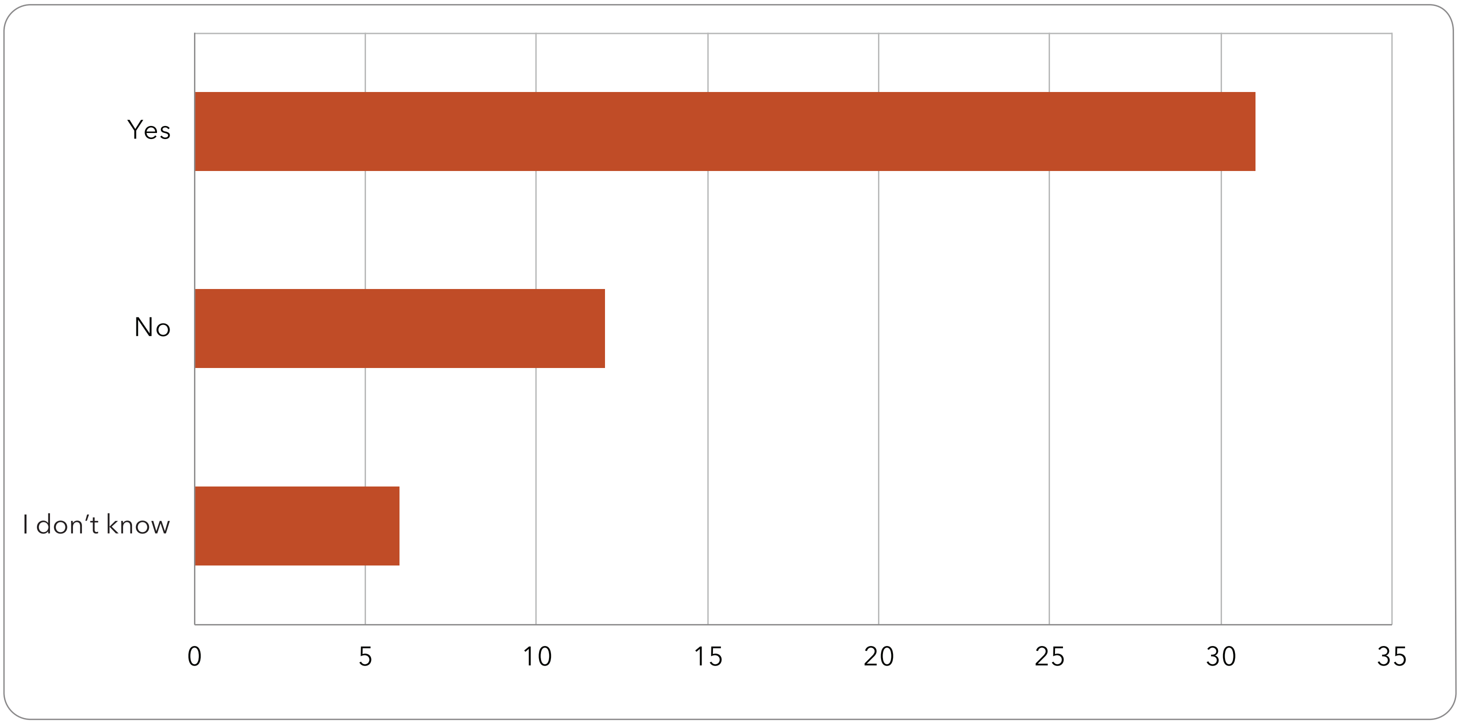
Details of those responses are as follows:

- Tracking or knowing the temperature inside my unit = 5
- Receiving alerts when it gets hot = 1
- Helping Home Forward improve cooling options and resources for all residents = 10
- Receiving payment for participation = 6
- All of the above = 2
- Previous tenant died in unit last summer = 1

After accounting for these responses, "Tracking or knowing the temperature inside my unit" was chosen a total of 15 times, "Receiving alerts when it gets hot" was chosen 4 times, "Helping Home Forward improve cooling options and resources for all residents" was chosen 31 times, and "Receiving payment for participation" was chosen 17 times.

Question 7

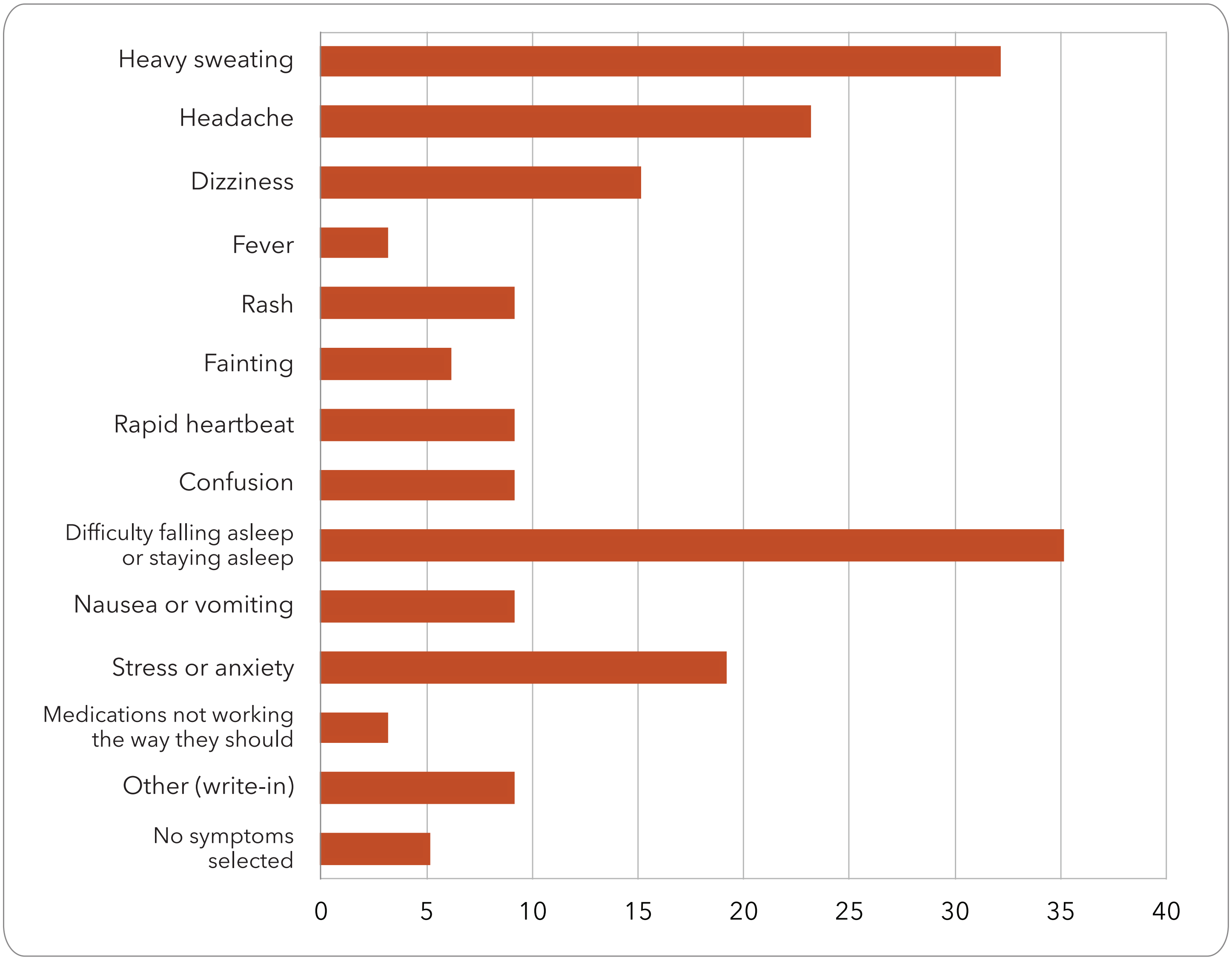
Do you have any health conditions that make you sensitive to heat?



Question 8

Since living in this building have you experienced any of these symptoms as a result of heat exposure inside your home?

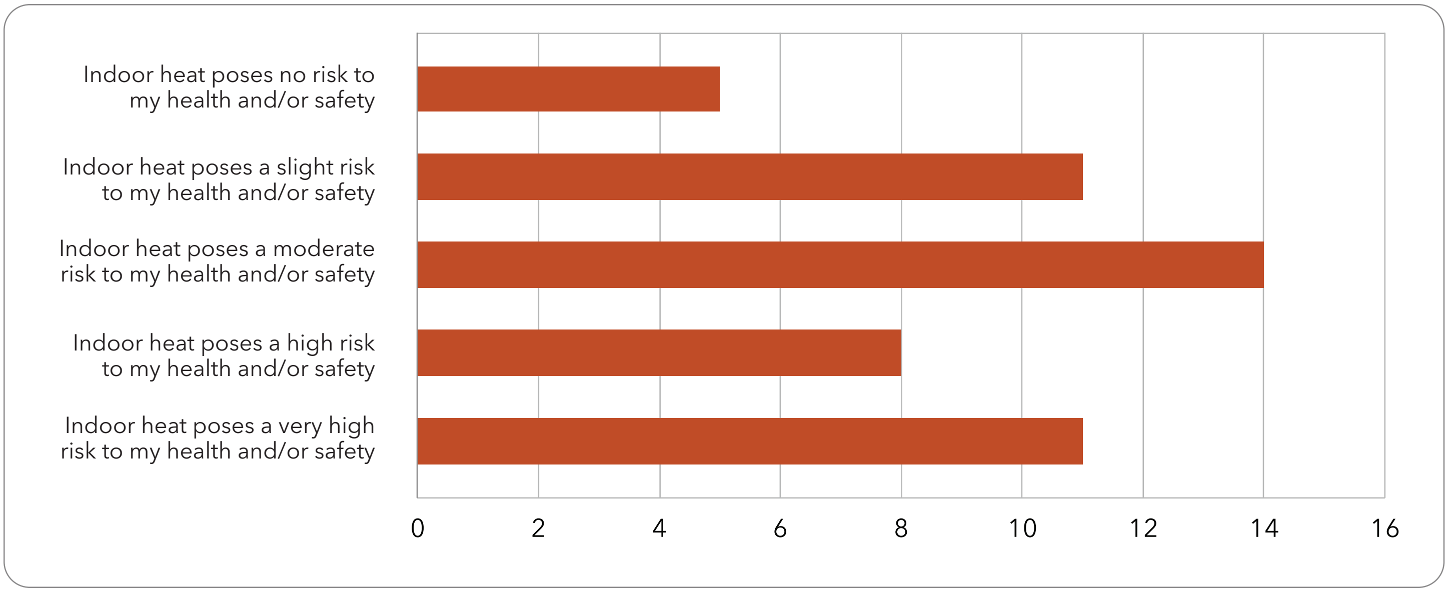
(select all that apply)



Write-in responses included difficulty breathing, tiredness, and feeling "bitchy," cranky, and angry. One resident noted that she gets heat stroke easily, which runs in her family.

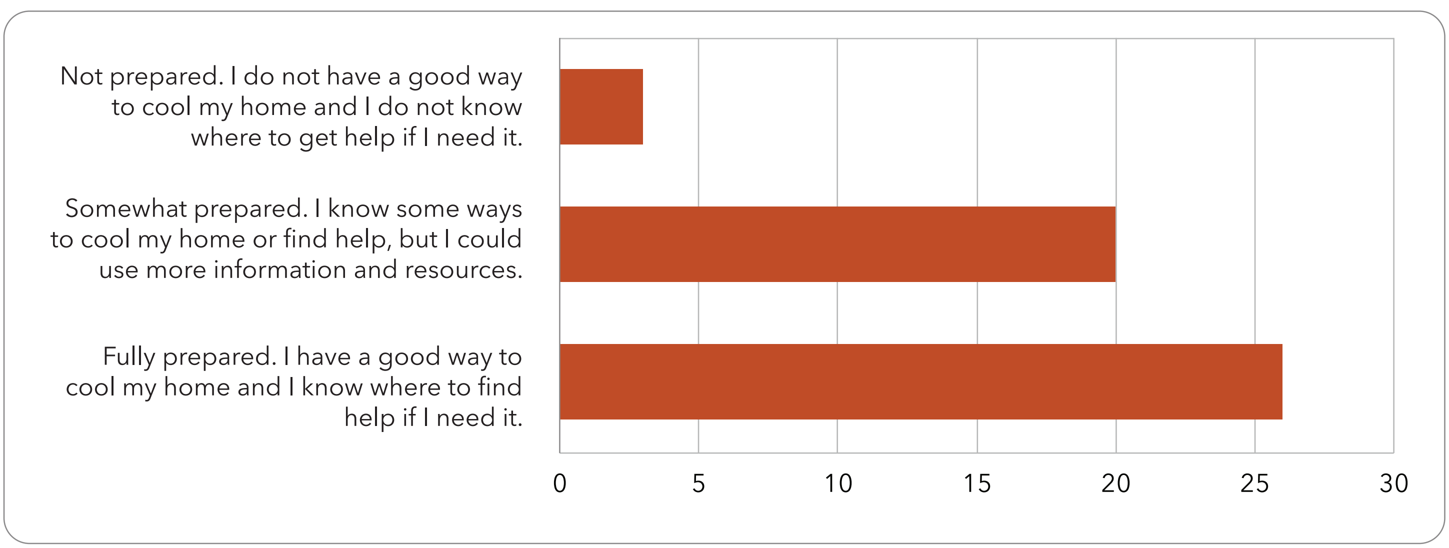
Question 9

How much do you think indoor heat affects your health and/or safety?



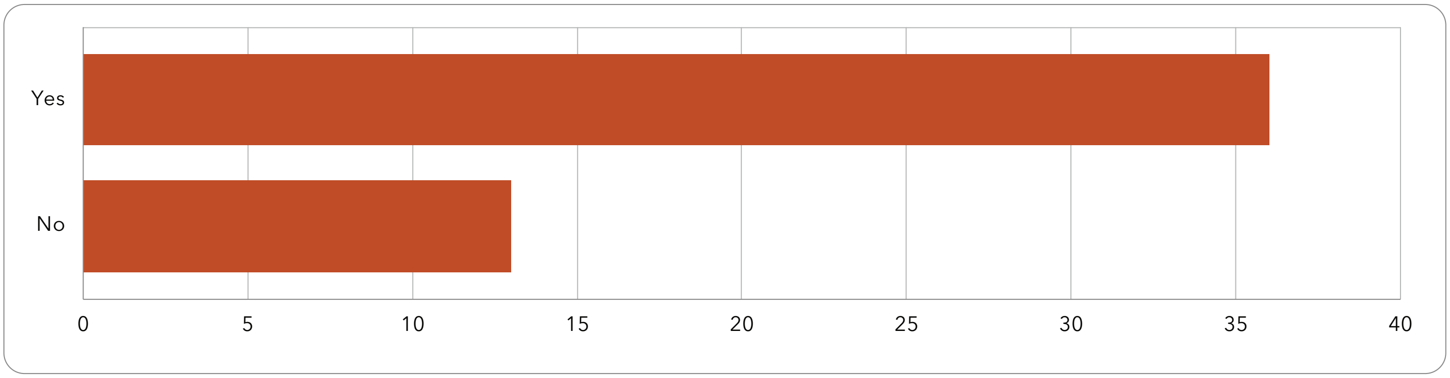
Question 10

How prepared are you to deal with indoor heat?



Question 11

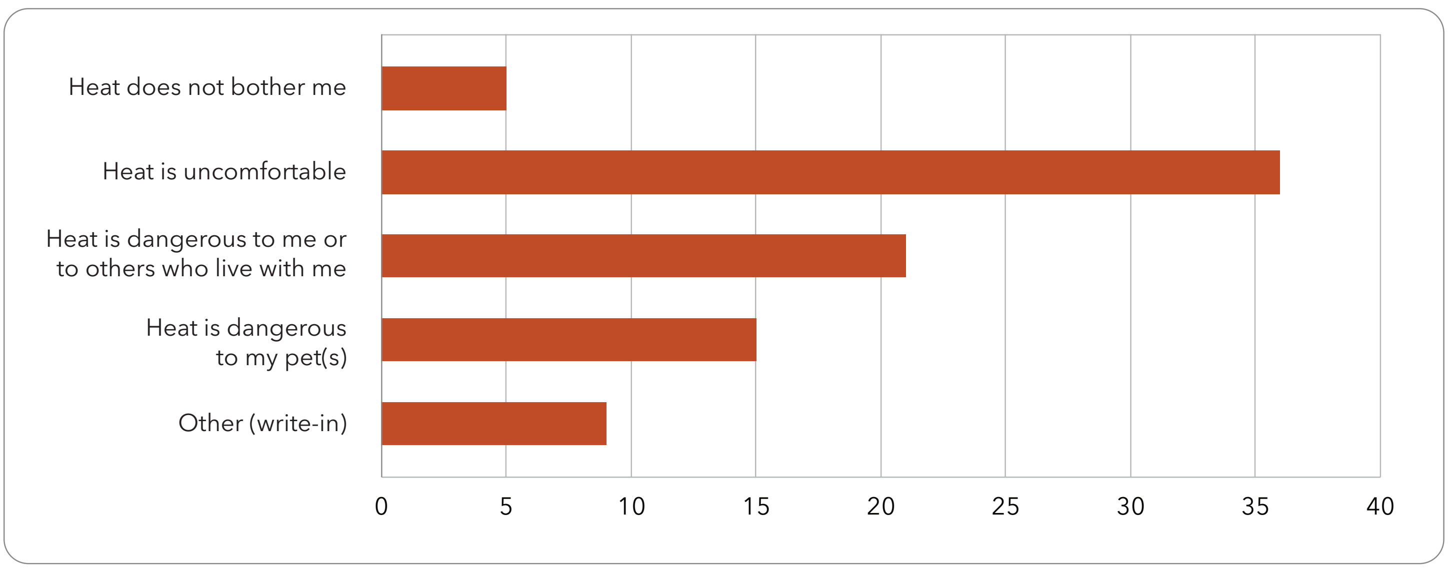
Do you own an air conditioner or have an air conditioner in your home?



Question 12

How do you feel about summer heat in your home?

(select all that apply)

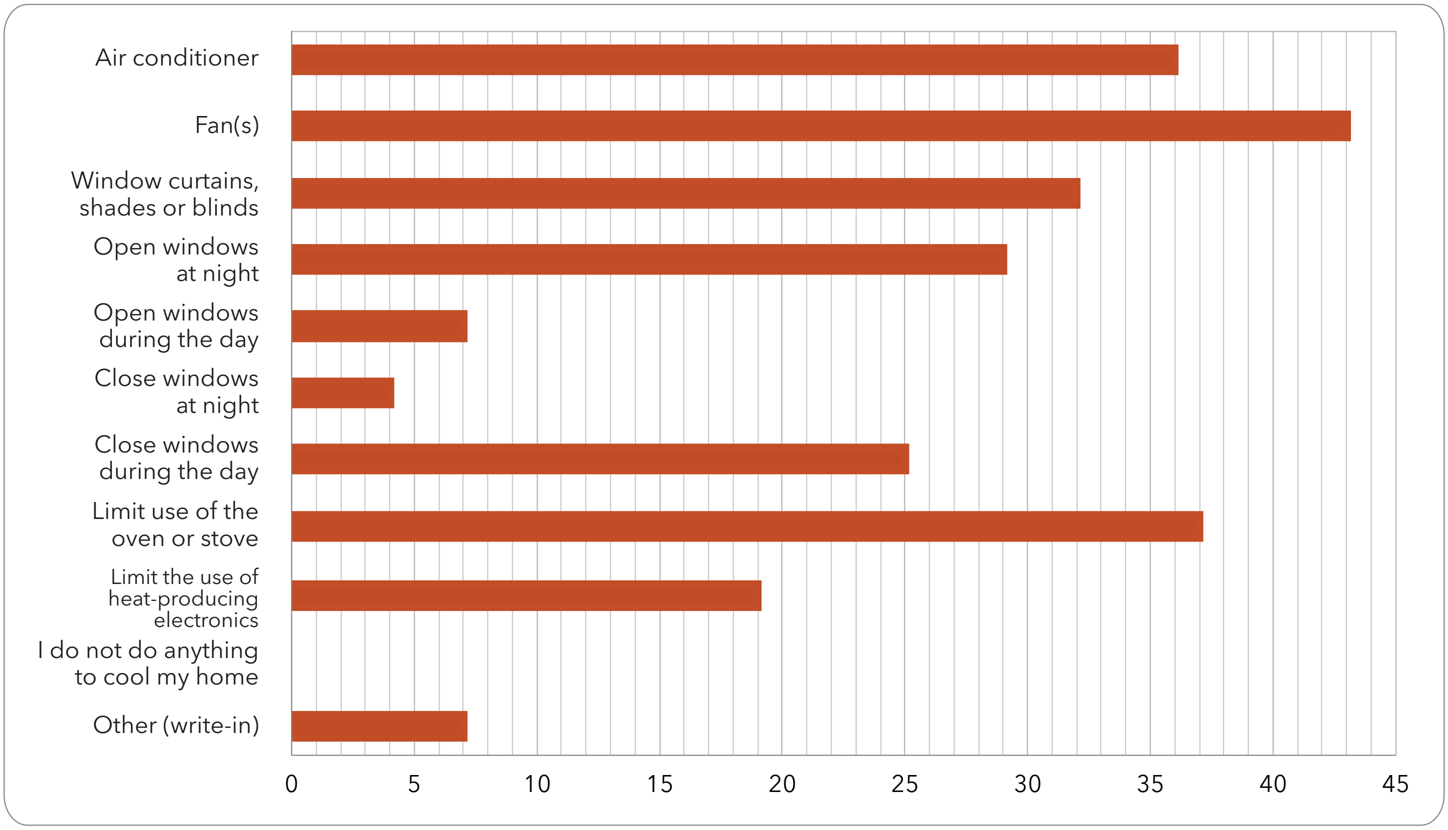


Write-in responses	
Devastating, awful	When medical arises its deadly
Keeps me from sleeping and sometimes eating	The hotter it gets, the harder it is for me to breathe.
I never needed AC all my life till 2 years ago.	Sometimes it feels like we live on the equator!
Bad for my plants too	Humidity; also, heat bad for computer/electronics
Being on the west side of the 7th floor the heat can get really, really bad from around 2ish PM to sunset, very miserable	

Question 13

How do you keep your home cool during the summer?

(select all that apply)

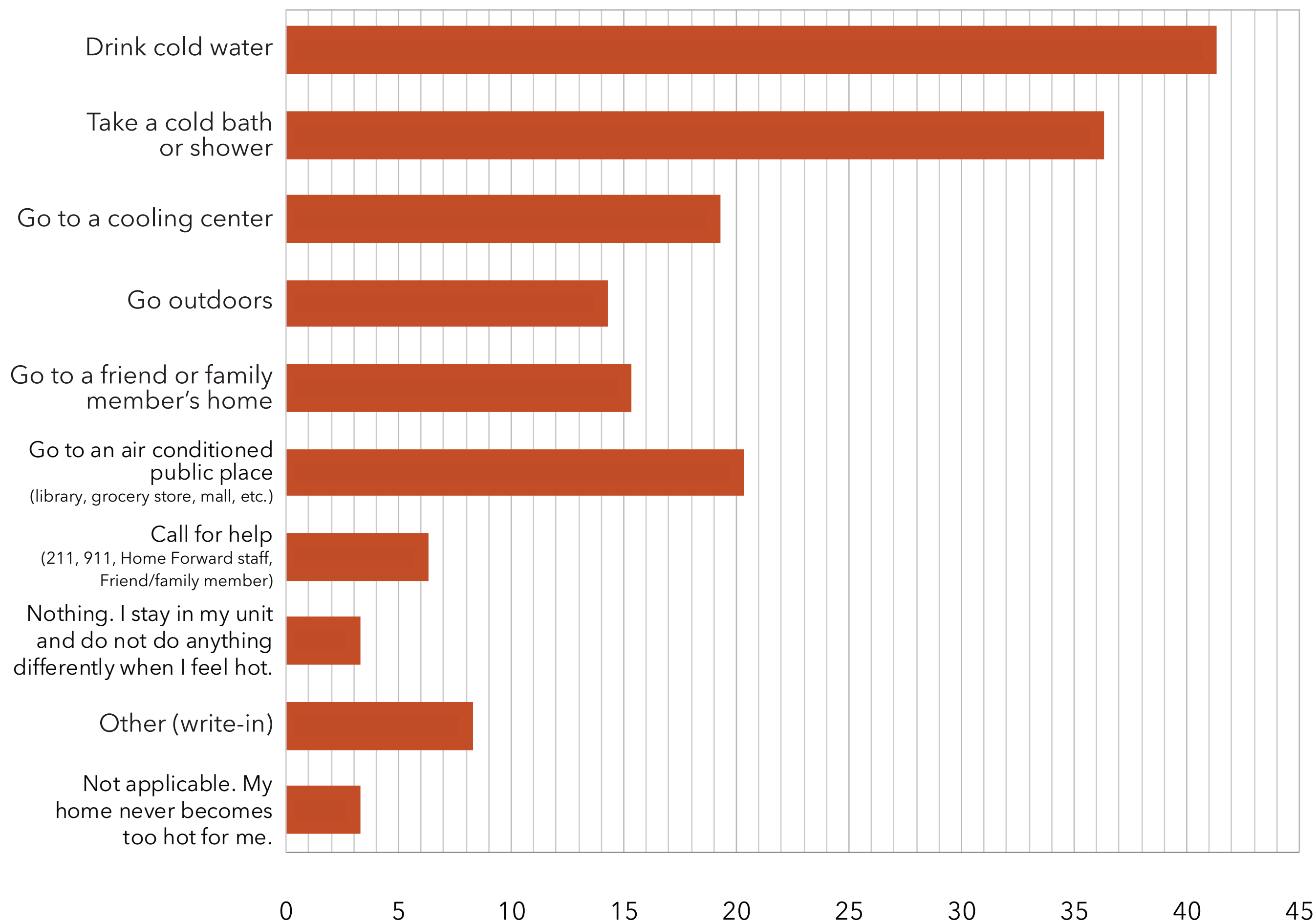


Write-in responses
Rotate air when possible; Get in cold shower, sit in front of a fan with wet towel
air hepa filter
Most of the year I keep [windows?] closed 24-7
I open windows in the early morning to cool things down.
Sit directly in front of a fan, or position one to blow on my bed while I sleep, try to sleep!
I tried opening the windows at night but too many bugs get in! I need screens!
Put reflective window insulation in all windows, Keep wet towels in freezer to put over fans, self, pets

Question 14

What do you do if you cannot cool your home and it becomes too hot?

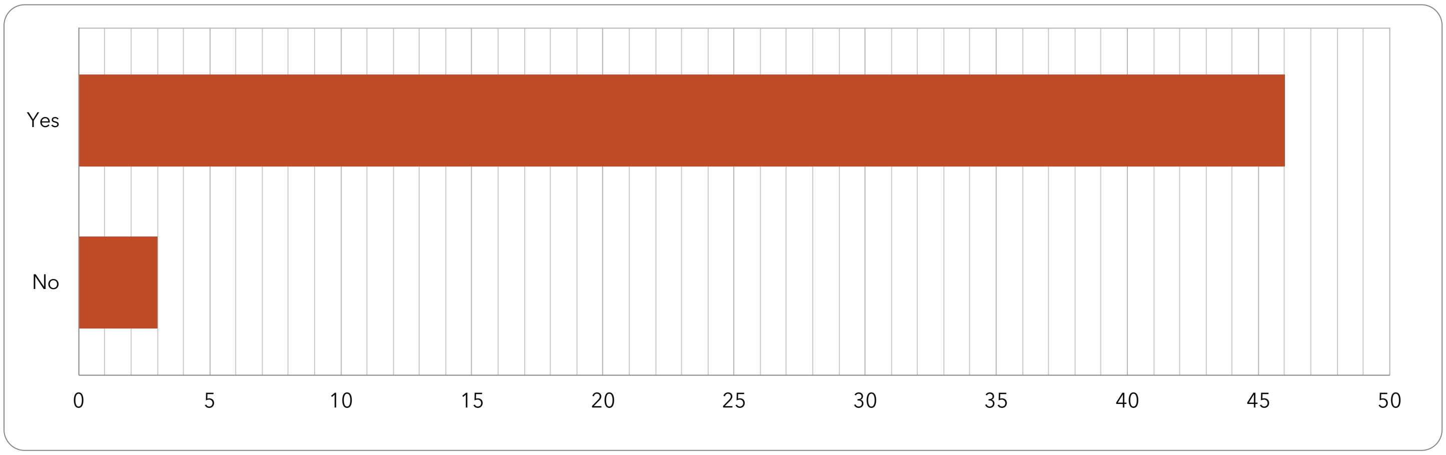
(select all that apply)



Write-in responses included drinking lukewarm water (which can be chugged) to stay hydrated, going to the community room "if it's open," going to a senior center, going to a water park, going to a hotel, "bitch a lot," and "suffer."

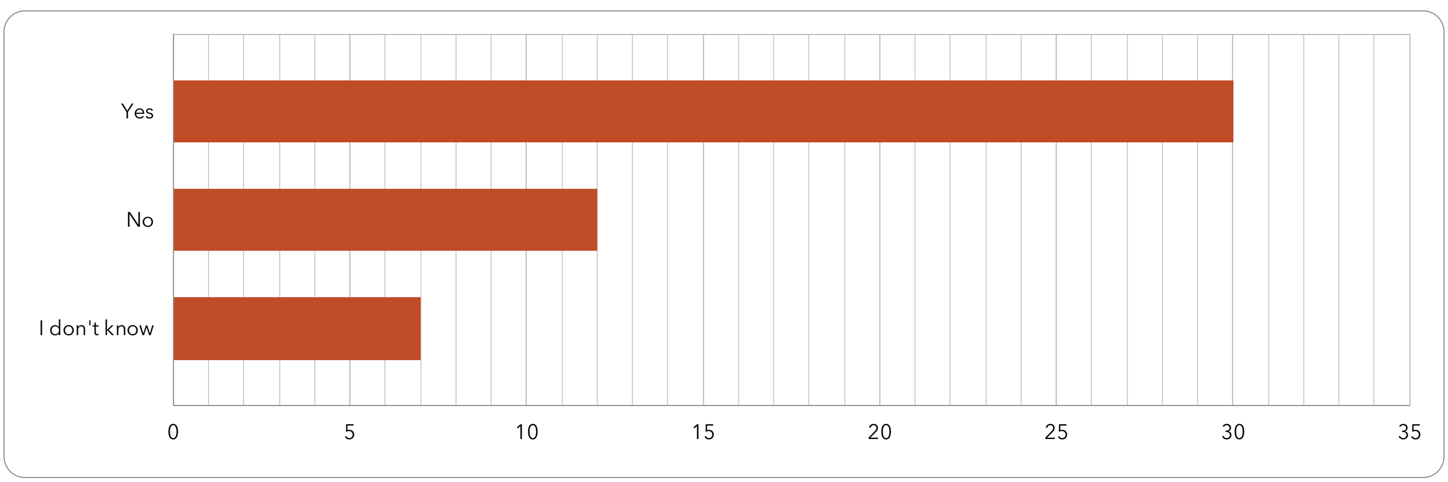
Question 15

Did you know that Home Forward provides a cooling center at your property on very hot days?



Question 16

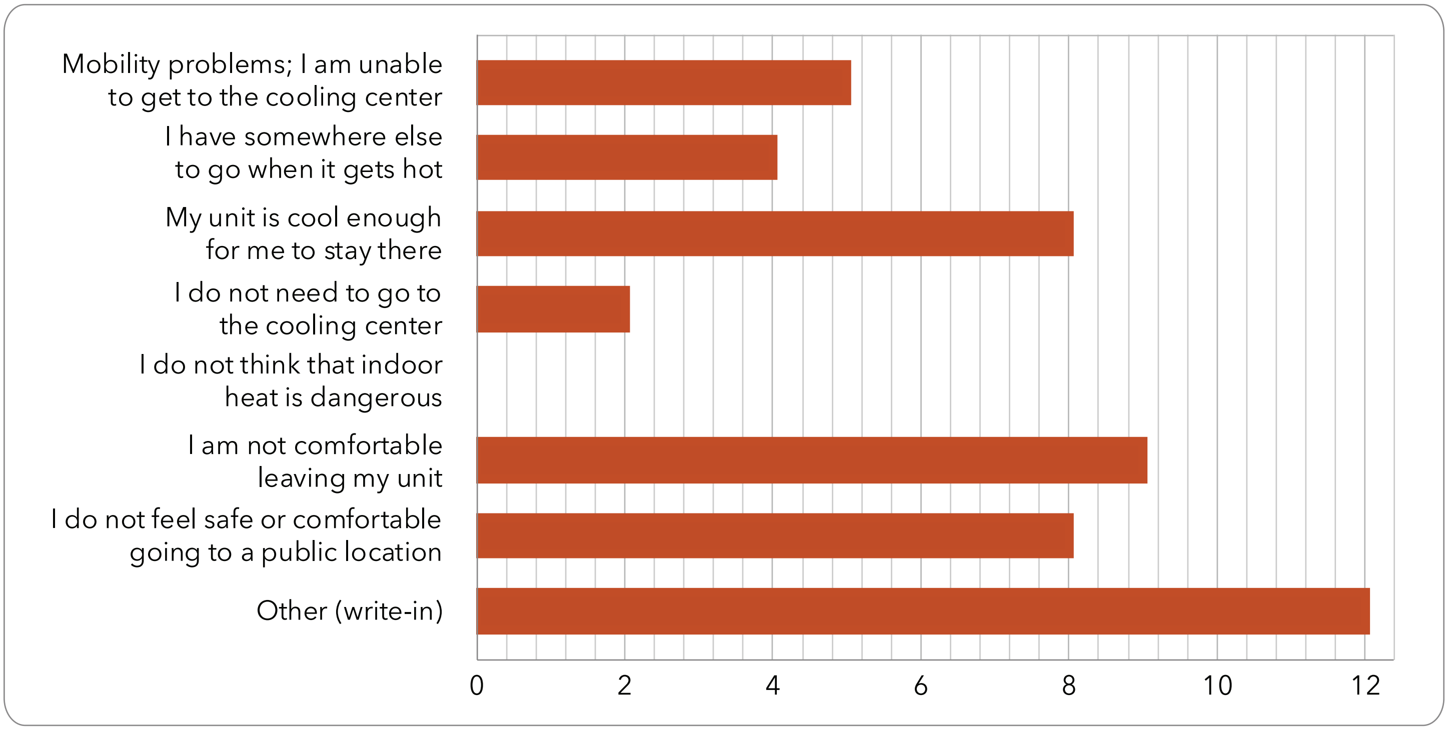
Would you use the Home Forward cooling center at your property?



Question 17

If you answered NO or I DON'T KNOW to the previous question, please tell us why you have not or would not use the Home Forward cooling center.

(select all that apply)



Write-in responses
During multiple hot 100+ degree days the AC stopped working and the maintenance refused to fix.
Don't want to bring bed bugs to my home ever again.
Depending on how crowded.
Some days it gets rather crowded with everyone and their pets. So my dog can be more comfortable/less stressed we use other options. But greatly appreciate the cooling room.
The area is small, too many people, no room for power chairs
I don't socialize with unknown people very well.
Don't really like a lot of people here.
I prefer to be in my own unit + or go outdoors to some water
Virus
Covid, etc.
My cat can't come w/ me

Question 18

Is there anything else you want Home Forward to know about summer heat in your home?

The content below reflects direct responses to Q18, and some handwritten notes that were left elsewhere on the survey form. In the latter case, the specific questions to which respondents' notes refer have been identified in *italics*.

It would be a hell of a lot cheaper to cool the whole building than purchase individual AC units every few years. *Response to Q16 about using the Home Forward cooling center:* Only if I was dying. *Notes based on a conversation with resident at the time of survey:* "The cooling center is BS. Once during 2 weeks of 100+ degree days the AC stopped working, maintenance was called but they came, said it was cool enough and left. There were two more days of broken AC the following weekend. It gets 100+ in the hallway." Resident wants central AC instead of individual ACs that need to be replaced.
I do not understand why there is air in offices but not in apts. I'm sure electric is a part of that but feel anyone would prefer to pay an extra 20.00 a month for central air.
I'm on the 14th floor, heat rises, it's hotter in here all night long. So when they close the community room I have no options but to go outside which is dangerous. People are not always friendly and security doesn't always walk the property consistently. *Response to Q8 about symptoms:* Have loaner AC right now but it got up to 96 in here. *Response to Q15 about the Home Forward cooling center:* Yes but it is not available at night. My house heats up more after 5pm so it's not available when I need it most.
Everyone needs to have better options to stay cool. Our community room needs to be open 24hrs/7d a week. *Response to Q15 about the Home Forward cooling center:* Not really. They close the community room before evening and weekends.
Concrete buildings can get hot during summer. I can feel the heat on the floor in my bathroom. There should be a central cooling system in the building. Tenants should be educated not to open the lobby windows (on each floor) when it's hot outside. The cool air becomes hotter when the windows are open.
I live in the west end of the front section of our property. My west wall continues absorbing heat from the sun until it sets. Then the west wall releases heat into my apartment like a damn pizza oven! I open both windows at night, as well as my door. I leave the door open until I go to bed! With fans on high (for a cross breeze, hopefully!) *Response to Q6 on reason for participating:* Home Forward houses some of the most vulnerable people in Portland. I feel a deep responsibility to do all I can to make a wide and lasting impact for my fellow residents!
clearly w/out any cooling systems, it gets extremely hot in these brick cement buildings.
Yes, I do need an air conditioner and possibly screens for my windows. So I can open in the evening and get cooler air. Bedroom stays hot!

If we could get screens on at least one window so at night we could open a window at night and not have bugs come in. Bite you.
As I mentioned before about the direct exposure to the hottest heat of the day. Besides air conditioning and fans I think (and have in the past requested) blackout curtains would be a great help. Plus screens for the windows, sometimes it's too buggy to open them.
It gets real hot....Where is the AC
My AC is set to 65 and I still get heat alerts. The bathroom never cooled.
With temps this high it helps perpetuate ideal living conditions for the vermin that reside here; I've never seen a cockroach complain about the heat rather than the opposite.
Not at this time - but tinted windows would help. *Response to Q13 about cooling the home:* Fans dry out my eyes and make my dog have eye discharge from being constantly on.
My worries about the heat are more about my cat than myself. It is hard for to move her due to her temperment. It is also difficult to find places that she will tolerate.
Just to be more prepared and to listen more to tenants when they have complaints/concerns on living situations.
I would stay cooler if the doors weren't so drafty. I can see under my door, also the sides have gaps.
When you look @ my temp/humidity log started with 1 reflective cover window the change was so dramatic I made another 2nd big temp reduction was new AC :) *Response to Q10 about preparedness:* Fully prepared with new AC and resources from [Home Forward]
There is a tree outside my windows. Please don't cut it down.
No real complaints.
I appreciate the cooling center in our building. I used it on several days when my dog or I became over heated.
Thank you
Thank you for trying to help.
I would like to thank them for the free air conditioner.
Thank you a million for the new air condition. It has been a joy and keeping cooling in my apartment. Thank for your services.

Notable Findings

The results of this survey provided insights into residents' experiences with heat, perceptions of their own risk and preparedness, and coping strategies used. These findings offer some guidance for future outreach by Home Forward, and for future iterations of this or a similar study among affordable housing residents. Several of these topics were explored during resident workshops and are covered in the next section, **Results: Workshop Findings**.

Resident perceptions and strategies:

- Most residents seemed aware of using best practices for cooling without an air conditioner, including opening windows at night and closing them during the day; limiting the use of the oven, stove, and/ or electronics that produce heat; using cool or wet towels; and using fans strategically to create airflow. This last finding was confirmed through site visits by the project team, during which multiple residents displayed complex setups involving multiple fans to create crossflow of air.

- Twenty-three residents surveyed (43%) noted feeling "not at all" or "somewhat" prepared to deal with extreme indoor heat. Of these individuals, 13 also indicated that heat is dangerous to them or someone who lives with them, and 12 identified heat as posing a high or very high threat to their health and/or safety. These findings suggest there are many residents who feel both threatened by and not fully prepared to cope with indoor heat. Future outreach might focus on understanding the source of perceived risks and ways to increase feelings of preparedness, either with cooling resources, health care support, or information.

- Many residents did not know whether they had an illness that made them sensitive to heat. Education on heat-sensitive conditions may be helpful.

Resident concerns and needs:

- Residents at NWT would like window screens so that they can more easily keep windows open and get cool air at night.

- Crowding and limited hours appeared as significant barriers with regard to residents' ability to access cooling centers. It is recommended that cooling centers be open longer hours, including at night, since evening/night is the hottest time of day for some units. Concerns about interacting with other residents were also expressed. This is likely not something Home Forward can easily address given that cooling centers are meant to be used by any and all residents. However, the presence of management or security personnel could possibly alleviate concerns, if funding allows.

- Difficulty falling or staying asleep was the most reported symptom related to heat exposure, selected by 35 residents (71%). This suggests that Home Forward and partner organizations may need to provide greater resources for keeping residents cool overnight, when most are inside their homes and have limited options for going elsewhere. Currently, Home Forward cooling centers are not open at night except during extreme heat events, and multiple residents expressed that they cannot/will not open their windows to let cool air in.

- Multiple residents expressed concerns about the safety of their pets, especially those that cannot easily go to the Home Forward cooling center. Home Forward currently has guidance for pets available online but that information may be useful in other formats.

Resident motivations:

- The majority of surveyed residents cited a desire to help Home Forward improve cooling options for all residents as their main reason for participating in this study. This suggests a strong willingness on the part of (at least some) residents to participate in studies that could benefit all tenants and bodes well for future research projects with this population. Desire to receive payment was the second most commonly cited reason, affirming that the project team should prioritize funding for resident remuneration in subsequent studies.

- Responses suggest that residents were not particularly enticed by receiving heat alerts; at least, this was not a primary reason for enrolling in the study. This is supported by the fact that, during sensor installation and setup, multiple residents opted out of receiving text or email alerts. Although the alerts feature was of particular interest to the project team, it may be worth excluding in future iterations of study if it is not valued by residents, and if it would give the team more flexibility in selecting a sensor.

Results:

Workshop Findings

Workshop Highlights

Two resident workshops were held as a follow-up to summer data collection: one at HWE with 12 participants, and one at NWT with 13 participants. During the workshops, a facilitator presented residents with temperature data collected inside their individual units and property-wide, as well as thematic content that emerged through the social survey. The participants provided feedback on and insights into the data, deeper information about their own cooling strategies, observations of relevant building conditions, and proposed action items. This section offers a synthesis of workshop content gathered from residents' verbal remarks (recorded in writing by the project team), and ideas recorded directly on posters and notes paper.

Theme 1: Barriers

When temperatures are high, health and emergency preparedness professionals recommend specific actions for safety. These apply to everyone, not just residents of affordable housing. For example, opening windows at night to let hot air out and cooler air in; getting fresh air or finding a cooler place if the home becomes too hot; and using an air conditioner if needed to keep at least one room in the home under 80°F. Through workshops, it became apparent that many residents experience barriers to acting on that guidance. Some noted challenges are categorized below.

Barriers to...			
Opening windows	**Seeking a cool space outside the home**	**Having or using cooling amenities outside**	**AC working effectively**
Air pollution	Unwillingness to leave home	Concerns about vandalism and theft	Drafty inside units at doors and windows
Dirt and dust coming in	Unwillingness to leave behind pets or assistant animals	Concerns about attracting unwanted non-residents to the property	Heat coming from the hallway / Hallway windows left open
Cigarette and other smoke	Discomfort mingling with others in the cooling center	Feeling unsafe outside at night with limited security *(from the survey)*	AC not started early enough in the day (to get ahead of heat)
Smells and sounds from trash storage and pickup	Preference to stay home and "sweat it out" even when very hot		AC old or insufficient for the space
Noise			
Crime			
Bugs and other critters getting in (NWT, no screens)			

Theme 2: Impressions of the study

During the workshops, residents were asked to comment on their experiences with the study: if they liked participating and thought the study was useful, if the data accurately reflected their experiences, if they liked receiving alerts or did anything differently because of them, and if they benefited from knowing the temperature inside their units.

Most participants were happy with the study and several reported that they enjoyed knowing the temperature inside their unit, which was visible on the UbiBot display screen. Impressions of the audio alerts were more mixed and less favorable. Hearing a temperature alert caused some residents to take special actions, for example, turning on the AC, taking the dog outside, checking on pets, drinking water (even if not feeling thirsty), laying down and limiting physical activity, and reducing use of the stove or oven. However, others noted that they already knew it was hot and the alert did not provide them with any new information, or stimulate any particular action in response. Some were confused by the sound when it occurred and/or just chose to ignore it.

Multiple residents expressed that the building-wide temperature data and/or the results presented in their 'Individual Unit Temperature Profile' were lower than what they expected. This was especially true for NWT, the hottest property studied. While some were speaking based on intuition (i.e., "it felt hotter than that"), others pointed to thermostat readings on their air conditioners, which were reading hotter than the UbiBot sensors at times. One possible explanation for this discrepancy is that ACs were located directly in or near windows and may have been receiving direct sun exposure. UbiBot sensors were intentionally placed away from ACs and were located at the interior of each unit, which may have been slightly cooler than the environment immediately inside windows. With regard to differences in feeling versus recorded temperature, one resident posited that humidity may be to blame, as a humid day even in the low 80s can feel very uncomfortable. Other residents indicated that their data made sense, and some saw expected, noticeable drops in their temperature graphs after an AC was installed.

A few residents did report new learnings from participating in the study. For example, a resident found that cooking increased the indoor temperature and sometimes triggered an alert from the heat sensor. Others found that their "comfortable" temperature was actually higher than they would have expected, at or over 80°F. For some, data reinforced what they already knew about the hottest times of day indoors (late afternoon to early evening).

Theme 3: Requests for assistance and support

Residents made some material requests which would improve conditions inside and outside of buildings; for example, installing central air conditioning, providing quality curtains, or adding shade structures outdoors. Specific items are shown in the table below, and a refined set of recommendations is provided in the **Recommendations & Conclusion** section. Notably, while residents would like help obtaining some amenities, there is an interest in self-sufficiency and care between residents. For example, several participants want instructional information related to AC setup and maintenance (which they could use themselves and to help other residents who are elderly or have physical limitations); training on CPR and heat first aid for both adults and children; guidance on how to set up their own cooling system at home (e.g., information about intake and exhaust fans, or different types of DIY insulation); and a resident-led check-in system with neighbors during a heat wave. The following table captures specific suggestions and requests made by residents within the five content categories discussed during workshops.

Requests for assistance and support				
Actions at the building level	**Information & communications**	**Amenities for individual units**	**Community-building activities**	**Other**
Central air	Alerts and posters about upcoming heat waves/weather	Darker thermal curtains	Ice cream socials	Need two AC units to cool ADA-sized apartment
Shade trees	Reminders to stay hydrated, about cooling center	Removable window tint (one suggestion for Phiferglass)	Welfare checks from management	Would like bars on windows due to fear of crime/intrusion
Misting stations (potential issue with this or other outdoor amenities is that they may attract undesirable non-residents to the property which some are concerned about)	Symptoms and signs of heat stroke, dehydration	Weather strips, etc. to close gaps around doors	Pet picture day included in activities	ACs are improperly fitted in windows and some leak water
Shaded outdoor seating area	Physical mail taped to the door (instead of or in addition to mail sent through the post)	Maintenance of AC units	Meet and check-in with neighbors [this could be organized and overseen by residents]	Heat triage, if a person is not sure whether or not they are in danger and need to be seen
Ice machine (locked for security)	Phone alerts	Sealing and fitted inserts around window AC units	Counselors, advocates, and/or floor wardens	If community room is open have security check it to make sure non-residents aren't sleeping in there
Ceiling fans (hallways)	CPR and first aid classes for kids and adults (In the past had college nurses give classes on heat related illness and signs)	Functional and efficient appliances (e.g., refrigerator and freezer might not work well; oven leaks heat so can't be used in summer)	Skill-building classes in the Community Room (cooking, CPR, health and sanitation)	For On-Site Cooling Center: Gloves and sanitary equipment, Activities (movies, acoustic music, etc.) to alleviate tension between residents, Longer hours, Snacks and ice water
Designated smoking area away from windows	Accessible information on maintaining own AC units (and on heating features as well)	Ceiling fans (in-unit) or oscillating fans for those who don't want an AC	Community network to help with maintenance of fans and ACs	Curtains would be preferable to slat blinds, which is what most units have
Shade shelters over existing picnic tables and around the property	Community resource booklet	Heat-blocking shade curtains or insulating pull-down shades	Two-way communication between residents and building managers so all can feel safe	Need to plug holes in the walls where old vents used to be; very drafty

Table continued on next page

Requests for assistance and support				
Actions at the building level	**Information & communications**	**Amenities for individual units**	**Community-building activities**	**Other**
Keep hallway windows closed on hot days	Info on what is permissible and available (re: cooling measures)	Water filters		Issues with hallway windows being left open on hot days
Kiddie pools/ swimming pool	Newsletter	Air purifiers		
Tree pruning needs to be done for tree health and safety, but shouldn't be overdone such that it eliminates shade	Extreme weather kits	Weather strips for doors and windows		
Green roofs where possible	Heat safety classes	Reflective insulation for windows; Window films		
	Information on services (cooling centers, transportation, food access)	Shade umbrellas or parasols [for outdoor use]		
	Weather alerts	Healthy food, fruit, hydrating food and beverage		
	Resources are on the HF website - share those more widely to increase awareness (some people don't use the internet)	Temperature gauges in all units (thermometers, etc. to complement thermostats on AC/heating appliances)		
	Newsletter	Maintenance of vents and AC filters (especially for those with mobility issues, physical limitations, elderly)		
	Electronic screen by elevators (with information and alerts)			

Theme 4: Unexpected study findings revisited

A few surprising results came out of the initial temperature study and analysis; notably, that the presence of AC, window direction, building story, and presence of tree shade did not have as much of an impact as expected. In fact, none of these factors appeared to have much influence at all. This likely has to do, in part, with the inherent limitations of a small sample size, and no concrete conclusions should be drawn about the influence of these various factors based on this study alone. That said, residents provided additional information, conveyed below, which also brings some clarity to these unexpected findings.

1. Units with AC were not significantly cooler, on average, than those without AC

As a reminder, sensors were intentionally placed away from air conditioners when possible. This alone does not explain the result because many units are studio-style (one large room) and newer ACs provided by Home Forward are designed to cool a space of that size. However, some 1 or 2-bedroom units did have the AC closed off in a room separate from the sensor.

- It was revealed in workshops that those without AC take extensive measures to keep cool: windows and blinds closed all day; heavy curtains or blankets over windows; lights and electronics off; homemade, tailored insulation on windows and doors; multiple fans in use, including intake and exhaust window fans. This may level the field, especially when some who do have an AC skip these other measures; for example, one resident with an AC reportedly did not use any kind of blinds or curtains in the summer and experienced high sun exposure.
- Some residents who have an AC intentionally keep it hotter inside; for example, setting the AC in the upper 70s to mid 80s.
- Inefficient building envelopes and air sealing within units at windows and doors makes ACs less effective. Some ACs are improperly sealed in the window; draftiness, and heat coming from hallways adds to the problem. For example, one resident said that 78 is as cool as his AC can get the room even though he sets it "as low as it goes." Some got heat alerts (at least 80°F) even when their AC was already on.
- Some residents are using old ACs which no longer function or are not sufficiently powerful for the space they are in. One resident with a very old AC did not sign up for a new one from Home Forward this year, knowing that there was a limited supply and not wanting to take away from someone who had no AC to begin with, though hers does not work well.

2. Window direction did not make a significant difference, on average

- Residents (especially at HWE) are fully aware of their window direction and the times of day that they receive the most direct sunlight. Those with high exposure go to great lengths to block out sun, which may even things out somewhat.
- There would likely be more of a difference based on window direction (i.e., west and south facing units would be hotter) if no one was covering their windows or strategically blocking out sun.

3. Upper stories were not significantly hotter than lower ones, and mid-level stories were sometimes much hotter than higher ones

- One resident speculated that higher stories have better airflow than lower stories which are blocked in by other buildings.
- Differences in sun exposure and window direction may be influential. One resident reported that his old unit on the fifth floor of HWE, which had nearly all-day sun exposure, was noticeably hotter than his current unit on the eleventh floor.
- Several of the noted barriers to opening windows primarily affect those on lower levels, such as noise, fear of crime/intrusion, pests from trees, and dust or dirt getting inside. It is possible that those living on upper levels are more inclined to open their windows and are more able to cool off that way overnight.
- Lower levels may be more affected by heat coming off of streets and sidewalks, as well as other sources of ambient heat at street level such as automobiles.

4. Tree shade did not make a significant difference to indoor temperature, on average

- This result is probably most attributable to the sample size, as only two units included in analysis from NWT and one from HWE had direct tree shade. It is not possible to draw conclusions or identify relationships based on numbers this small.
- The high-rise structures HWE and NWT were consistently hotter than PV, and units at PV cooled off more quickly in the evening (see *Analysis 3: Hourly Temperature Profile* on page 13). This finding is consistent with the understanding that small structures, spaced out amongst green space and trees, will experience better air circulation and shading, and higher cooling capacity. While street trees may not have been very influential at HWE and NWT, the presence of trees and green space appears to have made a larger difference at PV.
- Home Forward contracts a landscape maintenance company to prune trees on its properties. One resident shared that pruning is done to the extreme and significantly reduces the amount of shade provided. This may not have affected study results but is worth noting as an area of possible improvement.

Recommendations & Conclusion

Actionable Intervention Recommendations

Numerous actionable strategies have emerged through this assessment. These are in addition to ongoing efforts by Home Forward, in partnership with the Portland Clean Energy Fund (PCEF), to distribute personal air conditioners and heat pumps across all properties. Recommendations for next steps are based on data collected during summer temperature analysis and surveying, expanded upon in resident workshops, and discussed among project partners from PBEM, Home Forward, and MCHD. Notably, these recommendations apply only to existing Home Forward structures, as all new properties will be constructed with in-unit cooling. The list of recommendations does not capture all possible solutions, but does reflect those which appear to be most popular among residents, and most feasible according to project partners. While some can be achieved in the very short-term with relatively little effort – such as giveaways of shade curtains and thermometers – others will require additional staff resources from Home Forward and may take longer to implement. Any recommendations which require major structural changes – such as installing central AC in old buildings, or upgrading windows to accommodate screens – could only be achieved during periodic building rehabilitation which occur every several years. Not all buildings will be able to support central AC.

The table below classifies intervention recommendations according to (1) thematic content categories, and (2) expected time horizons for implementation.

<table>
<tr><th colspan="4">Actionable Intervention Recommendations</th></tr>
<tr><th></th><th>Short-term
Less than 1 year</th><th>Medium-term
1-5 years</th><th>Long-term
5-10 years</th></tr>
<tr><td rowspan="5">Personal Amenity Giveaways</td><td>Distribute thermal curtains</td><td></td><td></td></tr>
<tr><td>Distribute air purifiers to encourage opening windows</td><td></td><td></td></tr>
<tr><td>Distribute dehumidifiers</td><td></td><td></td></tr>
<tr><td>Distribute thermometers</td><td></td><td></td></tr>
<tr><td>Distribute window films or covers (removable)</td><td></td><td></td></tr>
<tr><td rowspan="5">Maintenance</td><td></td><td colspan="2">Provide professional weatherization, insulation, and/or sealing for doors and windows</td></tr>
<tr><td>Create accessible guidance for maintaining AC, changing filters, and preventing water leaks*</td><td></td><td></td></tr>
<tr><td>Proactively set residents up with AC filter maintenance, fitting ACs in windows, and plugging door gaps**</td><td></td><td></td></tr>
<tr><td></td><td></td><td>Install permanent screens in NWT (would require window redesign)</td></tr>
<tr><td>Install temporary window screens (magnetic or adhesive) in NWT</td><td></td><td></td></tr>
</table>

Property & Cooling Center Improvements			Install central AC during planned building rehabilitation, if the building can support it (may require upgrading the electrical system)
	Open the cooling center for evening hours during hot summer days, even when there is no official heat advisory		
	Keep the cooling center at a higher temperature (not too cold)		
	Offer more entertainment and distractions in the cooling center to diffuse tension between residents		
	Provide ice water and snacks, including healthy and sugar-free options in the cooling center		
		Provide security in the cooling center and outside the building, especially at night	
		Install outdoor shade shelters	
		Install cool roofs	
		Provide more trees and green space outside of the buildings***	
Information & Communications	Provide a resource booklet for resident education; include cooling actions people can take, how to implement them, available services, health and safety information, and nearby facilities for cooling*		
	Use paper notices for weather alerts near elevators and common areas (online resources are not typically accessed by residents)*		
	Provide classes on heat safety, first aid, and CPR		
	Provide information about identifying, preventing and treating heat illness using accessible channels (not only online)		

Community-Building Activities		Train residents to serve on Neighborhood Emergency Teams (NET)	
		Restart a property-based newsletter	
		Offer skill-building classes and social events in the community room (not tied to extreme weather)	

*In progress: Home Forward has begun working on this option.

**Home Forward offers these services, but residents do not always know that they are available, or know to ask for them ahead of the busy maintenance season (summer).

***For high-rise structures like NWT and HWE, street trees can only shade windows on lower stories, and may not be extremely effective at reducing indoor temperatures overall. Providing a cool, outdoor greenspace for all residents to use could be a more effective option for that type of property.

Conclusion

The Home Forward Indoor Temperature Assessment was the first project of its kind: an integrative quantitative-qualitative study of affordable housing properties, for which residents exposed to indoor heat played a significant role in collecting data, grounding results, and identifying solutions. This approach eschewed a top-down model of hazard-description and solutions-development, and enabled the project team to learn directly from residents. The project involved a novel cross-sectoral partnership between emergency management, affordable housing, and public health. This pilot assessment has yielded a range of actionable intervention strategies which Home Forward, PBEM, and other interested agencies can act on in the near term, as well as some which are strongly desired by residents but may require higher staff capacity or major structural renovations. The temperature, survey, and workshop data presented offer a guide for selecting interventions, providing resources to affordable housing residents, evaluating building features and designs, and crafting future studies.

It appears that concrete high-rises such as HWE and NWT retain more heat than the low-profile wood structures of PV; that personal AC units have considerable limitations, particularly when there are building envelope improvements needed for efficiency; and that tree shade, building story, and window direction do not significantly impact indoor temperature. However, the results of this limited study should not be used to draw firm conclusions for all Home Forward properties, or to declare exactly what does and does not work (for example, portable AC or tree shade). This study has raised important questions deserving further investigation and verification, for example: Do all Home Forward properties experience similar limitations with regard to the cooling power of personal AC? Is there a difference in how structures made of concrete versus wood, brick, or other materials trap and release heat throughout the day, or distribute heat among various building stories? Does the density of surroundings (e.g., urban core versus less populated periphery) change the way heat behaves inside high-rises? These questions and others may be answered through future phases of research, targeting additional Home Forward properties for comparison.

This assessment revealed the ways in which individual residents, with and without AC, work to keep their homes cool. Several of their strategies have proven effective, though some are extreme and burdensome. While residents do have some power in maintaining cool spaces, the responsibility to improve indoor temperatures should not be left only to them. As summer temperatures rise, accelerated by climate change and the urban heat island effect, residents in affordable and other precarious housing environments will increasingly face heat exposure and illness. This situation calls for holistic, cross-sectoral responses and shared responsibility among public agencies. Although Home Forward is not required to provide services for heat safety and preparedness, the agency as a whole is committed to improving conditions for residents. Initiatives to do so will benefit from the continued support of partners such as PBEM, MCHD, and PCEF. Additionally, a sustained emphasis on the voices of residents themselves – in other words, those who are directly affected by heat, as well as remedial programs and plans – should improve understanding and outcomes. Interventions are needed which draw on the complementary perspectives and capacities of cross-sectoral partners, and the insights offered by those personally exposed to high indoor heat.

Acknowledgements

Thank you to those who funded, facilitated, supported, and/or participated in this project.

Jonna Papaefthimiou, Chief Resilience Officer, City of Portland

Brendon Haggerty, Multnomah County Health Department

Hector Dominguez Aguirre, City of Portland

Leina Gonzalez Baird, City of Portland

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Home Forward resident participants

Appendix

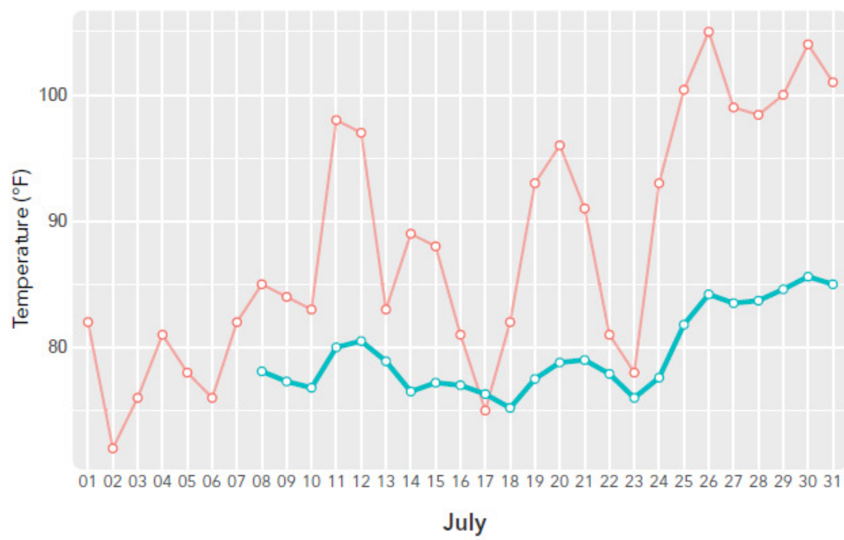
Appendix A

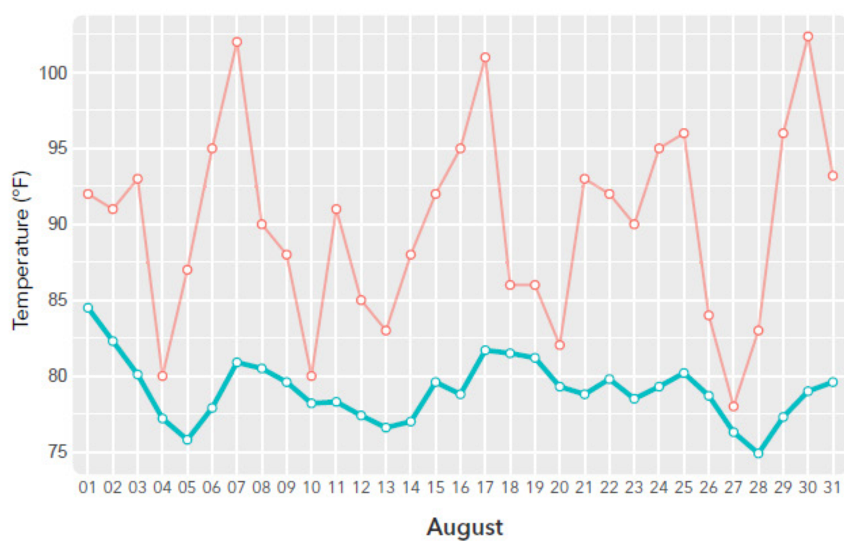
Individual Unit Temperature Profile (Generic)

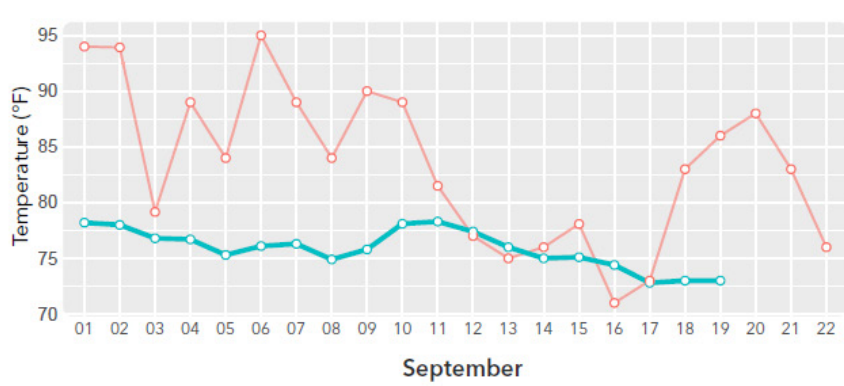
Home Forward Heat Monitoring Study

Daily Outdoor Maximum Temperature vs. Indoor Temperature

Outdoor temp   Unit temp







Sensor Summary

Inside Unit ###

84.1°F
Maximum Temperature

7/28
Date of Max Temperature

7PM
Average Hottest Time

78.8°F
Average Temperature

The graphs to the left show:

1. maximum outdoor temperature on each day of the study period ("Outdoor temp")
2. maximum temperature recorded in your unit on each day of the study period ("Unit temp")

Note: If you see a gap in the Unit Temp line, it means that your sensor was not recording data on that day.

Appendix B

Maximum Hourly Temperature by Sensor

		Maximum Hourly Temperature by Sensor														
Property	Sensor #	8:00am	9:00am	10:00am	11:00am	12:00pm	1:00pm	2:00pm	3:00pm	4:00pm	5:00pm	6:00pm	7:00pm	8:00pm	9:00pm	10:00pm
HWE	49	84.6	84.6	84.5	84.5	84.7	85	85.1	85.4	85.6	85.6	85.3	85.5	85.6	85.5	85.4
HWE	44	83.4	83.5	83.7	84	84.6	85.1	85.6	85.8	86	86	86.3	86.4	86.7	86.8	86.8
HWE	47	81.1	81	81	81.1	81.2	81.5	81.7	81.8	81.9	81.9	82.2	82.1	82.2	82.2	82.2
HWE	43	86.8	86.7	86.7	86.9	87.2	87.5	87.9	88.1	88.2	88.4	88.5	88.8	88.9	88.9	88.8
HWE	42	85.4	85.4	85.3	85.3	85.4	85.7	86.2	86.5	87	87.1	87.5	87.5	88.1	87.8	87.5
HWE	48	85.6	84.8	85	85.4	85.5	85.4	85.9	86.5	86.2	86.2	86.9	87.2	87.1	86.6	86.7
HWE	40	85.9	86	86.1	86.2	86.1	86.4	86.5	86.6	86.7	86.6	86.8	86.9	86.8	86.9	86.8
HWE	41	84.7	84.9	85	85.6	86.8	87.7	88.3	88.8	89	88.9	89.1	89.2	89.1	88.6	88.4
HWE	39	82.7	81.6	82.6	82.8	83	83.3	83.6	84	84.2	84.3	84.8	85.5	85.4	85.6	85.5
HWE	50	85.8	85.9	85.9	86.1	86.3	86.4	86.6	86.7	86.8	86.9	86.9	86.9	86.9	86.7	86.6
HWE	51	85	85.8	86.5	87	87.3	87.4	87.3	87.5	87.6	85.7	86.6	86.6	86.7	86.5	86.3
HWE	38	83.5	84	84.5	84.6	84.9	86.2	87.2	88.6	89.8	91.2	91.7	91.9	91.7	90	89.3
HWE	36	84.5	84.4	84.4	84.4	84.6	85.6	85.8	85.7	86	86.1	86	85.9	85.6	87.3	85.1
HWE	37	86.2	86	86	86.1	86.1	86.4	87.3	87.5	88.9	89.6	88.1	89.5	89.8	89	87.4
HWE	52	84.1	84.6	85.5	86.1	86.3	86.7	86.9	87.2	87.4	87.6	87.7	87	86.2	85.8	86
HWE	35	82.8	82.9	83.1	83.7	84.6	85.4	86.1	86.5	86.8	87	87.3	87.3	87.2	86.9	86.4
HWE	32	85.2	85.3	85.4	85.6	85.7	85.7	85.1	85	85.2	85.2	85.3	85.4	85.6	85.7	85.5
HWE	34	78.9	79.4	79.4	79.8	80.6	81	81.1	81.3	81.4	81.8	82	82.1	82.1	82.1	82.2
HWE	53	83.3	83.2	83.1	83.1	83.1	83.1	83.4	83.4	83.6	83.8	83.9	84.1	84.3	84.2	84.2
HWE	33	81.5	80.9	80.7	80.9	81.8	82.2	83.5	84	83.8	84.2	84.3	85	84.7	84.3	83.9
HWE	46	80.1	80.1	80.3	80.6	80.6	81	81	81.1	81.1	81.2	81.7	82	82	81.6	81.5
HWE	31	83.2	83.5	83.9	84	84.7	84.8	84.9	85	85.5	86	86.2	86.5	86.5	86.4	86.4
HWE	45	88.5	88.4	88.3	88.2	88.1	88.1	88.2	88.4	88.9	89.3	89.5	89.7	89.8	89.8	89.8
HWE	30	85.9	85.8	85.7	85.7	85.6	86.8	87.9	88.7	89.3	90	90.8	91.3	91	89.8	88.5
NWT	25	85.5	85.3	85.3	85.3	85.4	85.6	86	87.1	86.9	87.3	87.4	87.6	87.4	87.3	87.3
NWT	15	86.3	86.3	86.4	86.4	86.5	87	88.8	88.6	89.1	89.1	89.3	89	89.2	89.3	89.1
NWT	21	80.6	81.9	83.5	85	86	86.8	87.2	88	88.9	89.5	89.8	89.6	89	88.1	87
NWT	28	82.3	81.6	82	82.1	82.1	82.6	82.9	83.8	84.2	84.6	84.8	84.1	84	83.4	83.3
NWT	14	86.3	86.8	87.1	87.9	88.5	88.5	87.8	87.6	88.3	88.7	88.9	88.5	88.4	88.4	87.7
NWT	19	84.7	84.6	84.6	84	84.4	84.8	85.1	85.7	86.5	86.8	86.6	86.6	86.6	86	85.6
NWT	20	89	90	90.4	90.9	90.8	90.9	91.1	91.2	92.2	92.1	92.1	92	91.8	96.5	91.7
NWT	27	87.1	87.2	87.4	87.6	87.6	87.6	87.6	87.6	87.6	87.6	87.6	87.8	87.9	87.9	87.9
NWT	18	84.3	84.3	84.2	84	84.4	84.8	85.7	87.2	88.4	89.6	90	90.7	90.9	89.7	88.9
NWT	17	84.4	84.4	84.3	84.2	84.3	84.4	84.8	85.3	86.4	87.3	87.8	87.8	87.3	86.5	86.3
NWT	16	84.7	85	86	86.5	86.4	86.8	87.8	88.4	90.3	91.3	92.2	92.2	89.2	89	88.1
NWT	29	89.5	90.5	91.4	91.6	91.7	91.6	91.7	91.8	92.3	92.6	92.8	92.8	92.4	92	91.1
NWT	13	84.4	84.3	84.4	84.6	85.2	85.7	86.5	87.8	89.3	90.7	91.8	91.8	91.7	90.8	90
NWT	12	86.8	87.8	88.6	88.9	88.9	88.8	89.1	89.7	90.2	90.6	90.7	90.4	90.1	89.2	88.4
NWT	11	79.6	81.1	81.6	81.4	81	80.6	81	81.4	82	82.1	82.4	82.8	82.8	82.5	81.9
NWT	10	82.4	82.3	82.5	82.7	83.1	83.9	84.5	86.3	88	89.8	91.1	91.4	91.2	90	89.1
NWT	8	82.9	83.5	83.4	83.4	83	83.5	83	82.8	82.7	84	84.5	83.8	84.3	83.6	83
NWT	9	86.2	86.2	86	86.1	86.3	86.4	86.7	87.3	88.3	88.7	89.8	90	89.7	89.3	88.9
NWT	7	81.1	81.2	82.1	81.4	81.6	82.6	83.4	84.4	86.9	85.3	86.8	88	87.7	86.3	84.5
PV	1	81.9	81.6	81.3	81.2	81.4	81.8	82.3	83.1	84.1	84.5	85.8	86.4	86.5	86.5	86.4
PV	2	80.7	80.9	81	81.4	82.1	82.6	83.2	83.2	84.1	84.5	84.5	84.7	84.7	84.6	82.4
PV	3	79.8	79.6	78.6	78.8	78.6	78.9	79.5	79.8	79.4	79.9	80.3	80.1	80.5	80.7	80.7
PV	4	81.8	81.5	80.7	80.8	81	81.7	82.6	83.1	84.4	85	85.6	85.1	85.1	84.8	84.4
PV	5	82.9	83.6	84.2	84.2	84.3	84.3	84.6	84.9	85.2	85.2	85.7	86	85.6	84.9	84.9
PV	6	79.6	79.3	79.8	80.3	81.5	82.4	82.9	84.2	85.6	86.8	87.4	87.7	87.9	86.2	85.2

CAPA
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