



ENERGY EFFICIENCY & INDOOR ENVIRONMENTAL QUALITY

# Pre- and Post-Retrofit Survey Analysis

JULY 2018



## EXECUTIVE SUMMARY

The Atmospheric Fund (TAF) and building owner have undertaken energy efficiency and indoor environmental quality (IEQ) improvements in seven multi-unit residential buildings. The IEQ monitoring program focused on evaluating resident comfort and satisfaction. As part of this program, TAF commissioned pre-retrofit and post-retrofit resident surveys at the seven participating buildings.

The pre-retrofit survey took place over a week in February 2015. The results established baseline resident perceptions of IEQ and provided input to the retrofit design process. Since residents can perceive spaces differently, it was important to conduct surveys to prioritize and evaluate comfort issues before implementing any building improvements, as well as gather data to evaluate the IEQ impacts post-retrofit. The surveys also helped to contextualize the indoor environmental data collected over the past three years.

The energy and IEQ retrofits reached substantial completion on March 1<sup>st</sup>, 2017, and the post-retrofit survey was conducted in March 2018. This report compares resident responses from the pre-and-post retrofit surveys.

### Thermal Comfort

- **Winter:** Perceived overheating decreased by 54 per cent across all sites. Highest reductions were at sites AB and CD. These sites also reported an increase in under-heating, while building E, F and G site EFG reported a 55 per cent decrease.
- Monitoring revealed that post-retrofit interior temperatures did not fall below 22.5°C at any site.
- On average, 63 per cent of residents across all sites who reported under-heating also reported opening their balcony doors or windows.
- **Summer:** Residents at sites AB and CD reported decreases in heat-related discomfort by 37 per cent and 27 per cent, respectively. Site EFG saw a 43 per cent increase, likely due to increase in perceived over-heating.
- **Temperature consistency:** improved across multi-bedroom apartments at site CD. 'Just right' responses increased to 46 - 51 per cent. Overheating in the summer decreased across all rooms, and especially the kitchens. Wintertime under-heating decreased by 43 per cent across all rooms within the units.
- **Dryness and Condensation:** reported daily instances occurred less frequently. There was a 25 - 50 per cent reduction of daily reported condensation and 20 - 37 per cent reduction of reported daily dryness.

### Active and Passive Comfort Controls

- Portable heater use decreased by 69 per cent during the winter.
- Weekly fan use during the winter, though uncommon, doubled post-retrofit. Weekly use of air conditioners during the summer also increased by four per cent; this was likely the result of a hotter 2017 summer (reference for post-retrofit surveys) compared to the 2014 summer (reference for pre-retrofit surveys).
- Reported window opening during the winter has decreased by 39 per cent. This is a

significant improvement resulting from mechanical system retrofits that were implemented (condensing boiler installation, in-suite thermostat controls).

#### Drafts and Odours

- Reported presence of drafts (bathroom exhaust, windows, and doors) has decreased by 21 per cent across all sites.
- Frequency of unwanted odours has decreased. Largest reductions were in odours from neighbouring suites (31 per cent), followed by own cooking odours (28 per cent) and outside odours (20 per cent).
- There were fewer post-retrofit survey complaints surrounding intrusion of smoke from neighbours.
- Use of odour control strategies (air filtering, air-fresheners, candles) decreased considerably, although a minority of residents used these strategies to begin with.

#### Health Outcomes<sup>1</sup>

- Reports of fatigue, tiredness, headaches, irritated eyes, dry throat, cough, dry skin, runny nose decreased by 28 - 57 per cent.
- At site CD, where the highest percentage of residents leave for work/school, absences due to an illness decreased by 35 - 81 per cent.
- Reported hospital visits over a three month period decreased at sites AB and CD by 37 per cent but increased at site EFG by 69 per cent.

#### In-Suite Smart Thermostats Thermostat

- 65 per cent of residents at sites AB and CD were either satisfied or very satisfied with their smart thermostat. (No thermostats were installed at site EFG).
- 19 per cent (site AB) and 33 per cent (site CD) of respondents reported having no difficulties using the smart thermostats. Difficulties that residents did report were related to adjusting the temperature (19 per cent) or finding the technology too confusing (16 per cent).
- Integration with an air conditioner was the most frequently requested additional feature.

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<sup>1</sup> This study is not meant to provide a comprehensive health assessment of residents. Therefore changes in health reported symptoms could be due to non-building related factors.

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## IEQ PROGRAM SITES AND STUDY PARTICIPANTS

The IEQ program participating buildings included in this report belong to three sites, which will remain anonymous for the purposes of this report. The table below identifies each sites' pseudonym as well as its building components:

Table 1. Site names and composition

Site names	Site Composition
Site AB	Building A & Building B
Site CD	Building C & Building D
Site EFG	Building E, Building F & Building G

Three of the study buildings are populated by seniors (buildings A, B and F), two house families including children 18 and under (buildings C and D), and the remaining are bachelor style apartments.

Approximately 63 per cent of survey respondents have participated in both the pre-and-post retrofit surveys. The majority of residents surveyed (87 per cent) have lived in their units for two or more years, an increase from the pre-retrofit survey.

Reports of smoking amongst interview participants also increased at all buildings except for building G. At buildings C and D, young children (age 0-5) increased by four per cent, while children (age 6-12) decreased by four per cent. Appendix A provides more information on resident demographics.

Table 2. Study Participants

Building	Total Number of Units Surveyed		Units Surveyed as a Percentage	
	Pre-Retrofit	Post-Retrofit	Pre-Retrofit	Post-Retrofit
A	30	27	15%	13%
B	25	23	15%	15%
C	33	12	15%	5%
D	6	3	10%	5%
E	31	11	16%	6%
F	25	28	15%	17%
G	30	36	15%	18%
<b>TOTAL</b>	<b>180</b>	<b>140</b>	-	-

## Consistency of Survey Responses

TAF evaluated the consistency of survey responses by asking a sample of 10 residents across the seven sites to retake the same post-retrofit survey a few weeks after their initial responses in March 2018.

Residents' answers were compared against their own to determine how consistent the responses were and how often they responded with the same answer. Under ideal conditions, residents would have the same responses at the time the survey was retaken. Although there is a reasonable degree of consistency in responses, a significant share of variance between pre-and-post retrofit may reflect baseline variation driven by mood, memory, or recent conditions and experiences at the time of the survey. Table 3 presents the average consistency of responses per topic, where a higher percentage reflects a higher number of the same answers. Individual question consistency ranged from 33-100 per cent.

Table 3. Consistency of Responses by Topic

Topic	Consistency of Responses
<b>General Info/Demographics</b> Years lived in building, number/age of residents, etc.	86%
<b>Thermal Comfort</b> Instances of feeling too hot, too cold. Use of heaters, fans, or A/Cs, etc.	78%
<b>Drafts &amp; Odours</b> Instances of drafts, and odours from inside and outside the units.	66%
<b>Health Outcomes</b> Experience of health symptoms, days missed from work/school, and hospital visits.	73%

For some survey questions, TAF asked residents to describe their experience or perceptions separately during the summer and winter periods. Overall, there were no large differences in the consistency of responses between seasons. Despite the survey itself being conducted in the winter, summer opinions on thermal comfort were five per cent more consistent than winter conditions, as shown in Table 4.

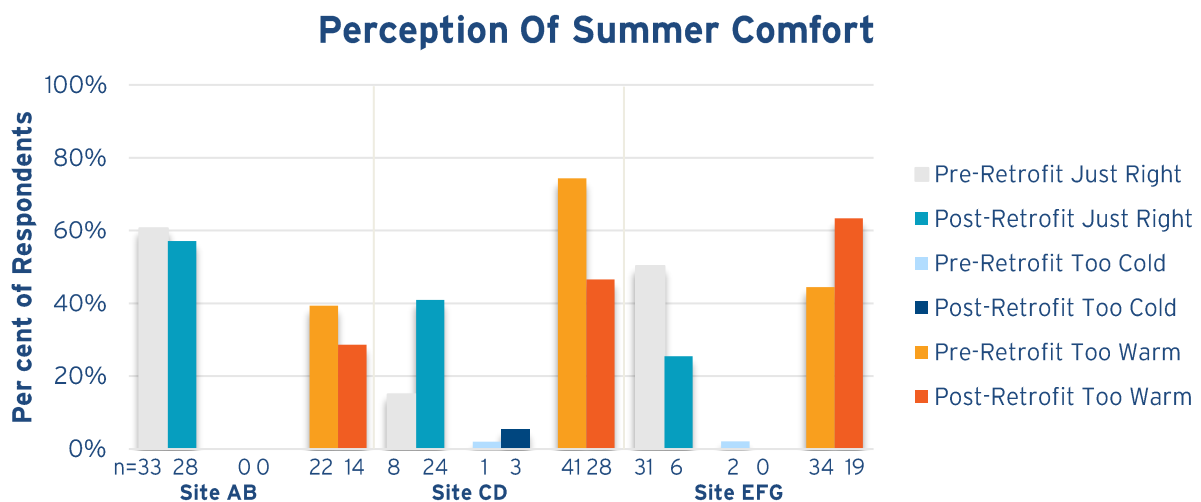
**Table 4.** Consistency of summertime and wintertime responses

Topic	Consistency of Responses	
	Summer	Winter
<b>Thermal Comfort</b> <sup>2</sup> Instances of feeling too hot, too cold. Use of heaters, fans, or A/Cs, etc.	83%	78%
<b>Odours</b> Instances of odours originating from inside and outside the units.	77%	75%

## THERMAL COMFORT

Perceived thermal comfort was a key focus of the pre-and-post retrofit resident surveys. TAF analyzed changes in resident responses with respect to overheating (“too warm”), under-heating (“too cold”), and “just right” responses for summertime and wintertime conditions.

Figure 1 shows resident perceptions of thermal comfort during the summer. Summertime responses of overheating at site CD decreased by 37 per cent, the largest reduction across the seven buildings. Site AB had a 27 per cent decrease in overheating responses, whereas site EFG overheating responses increased by 43 per cent. Summer under-heating does not seem to be as prevalent in the pre-and-post retrofit surveys<sup>3</sup>, where changes in post-retrofit conditions were very small (less than three percentage points).



<sup>2</sup> There was a seven per cent increase of post-retrofit respondents that answered “don’t know” to the summer thermal comfort questions compared to the pre-retrofit survey.

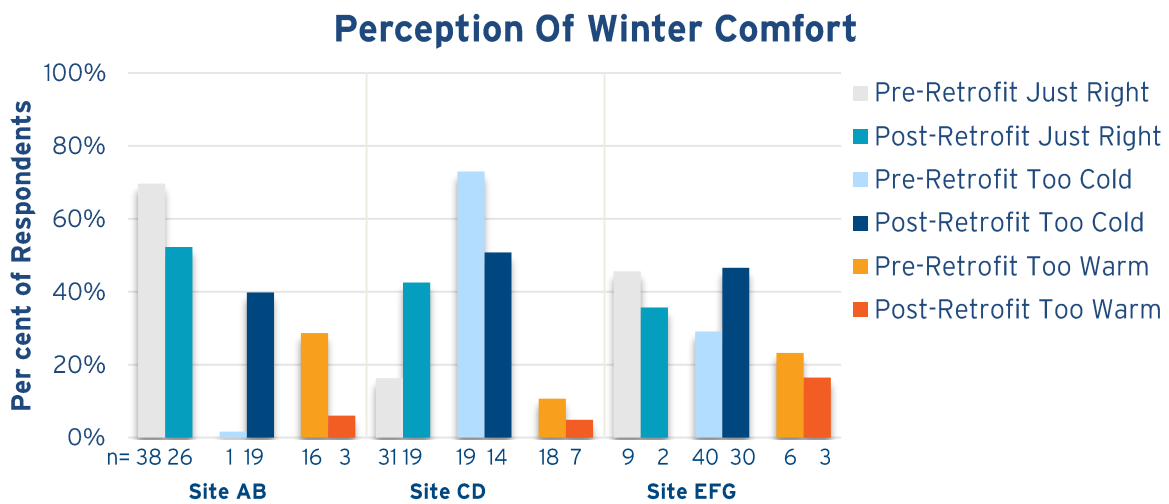
<sup>3</sup> The 2017 summer (reference for post-retrofit surveys) had 32 per cent more cooling degree days than the 2014 summer (reference for pre-retrofit surveys). This indicates that the 2017 summer was considerably warmer.

**Figure 1.** Summertime comfort, by site. N-values represent actual number of responses. “Don’t know” responses are not shown: 0 per cent (pre) and 14 per cent (post) at buildings A and B; 9 per cent (pre) and 7 per cent (post) at buildings C and D; and 3 per cent (pre) and 11 per cent (post) at buildings E, F and G.

Site CD had the largest increase in thermal comfort satisfaction, where “just right” responses more than doubled in the summer. At site AB “just right” responses decreased by six per cent; however, this may be a result of “don’t know” responses increasing by 14 per cent. At site EFG, “just right” responses decreased by 49 per cent, most likely due to the increase in perceived overheating.

Improvements in ventilation through the installation of new fresh air units and duct cleaning have resulted in a reduction of perceived overheating during the summer, despite 2017 having been considerably warmer than 2014<sup>3</sup>. At site AB, the project team introduced air tempering to the fresh air units, resulting in modest improvements. TAF is exploring further reductions of the hallway temperatures and the potential to take advantage of free cooling.

Figure 2 shows winter perceptions of thermal comfort. Post-retrofit resident surveys reveal an average 54 per cent decrease in perceived overheating responses during the winter period across all sites. Overheating decreased by 79 per cent at site AB, 29 per cent at site EFG, and 55 per cent at site CD. In general, the lower floors at building D saw the most reductions in overheating (see Appendix C).



**Figure 2.** Winter comfort, by site. N-values represent actual number of responses. “Don’t know” responses are not shown: 0 per cent (pre) and 2 per cent (post) at buildings A and B; 0 per cent (pre) and 2 per cent (post) at buildings C and D; and 2 per cent (pre) and 1 per cent (post) at buildings E, F and G;

At site AB, 38 per cent of respondents felt that their units were under-heated in winter post-retrofit, however, there were inconsistencies between the two buildings. At building A, 57 per cent of respondents reported under-heating while building B had 23 per cent of respondents reported the same issue. Monitoring revealed that post-retrofit interior temperatures during the winter did not fall below 22.5°C. Further analysis revealed a correlation between residents opening balcony doors or windows in winter, and reported under-heating. At site AB,



between 67-70 per cent of residents who reported under-heating also reported opening balcony doors or windows.

At site EFG, under-heating responses also increased from 29 per cent to 47 per cent, on average, due to a disproportionate amount of residents on the lower floors of building E reporting under-heating when compared to the rest of the site. Similarly to site AB, between 50-100 per cent of residents at site EFG who reported under-heating also reported balcony door and window opening.

Site CD saw a 55 per cent decrease in winter under-heating, indicating that the newly installed boilers and in-suite thermostat controls are having their intended effect<sup>4</sup>. Of those who reported under-heating, 44-64 per cent also reported opening balcony doors or windows. Understanding the relationship between balcony door or window opening and under-heating not only helps contextualize the increase in under-heating responses, but **also reveals that** tenants may take some time to modify behaviour that they have been previously accustomed to, despite measured thermal comfort improvements.

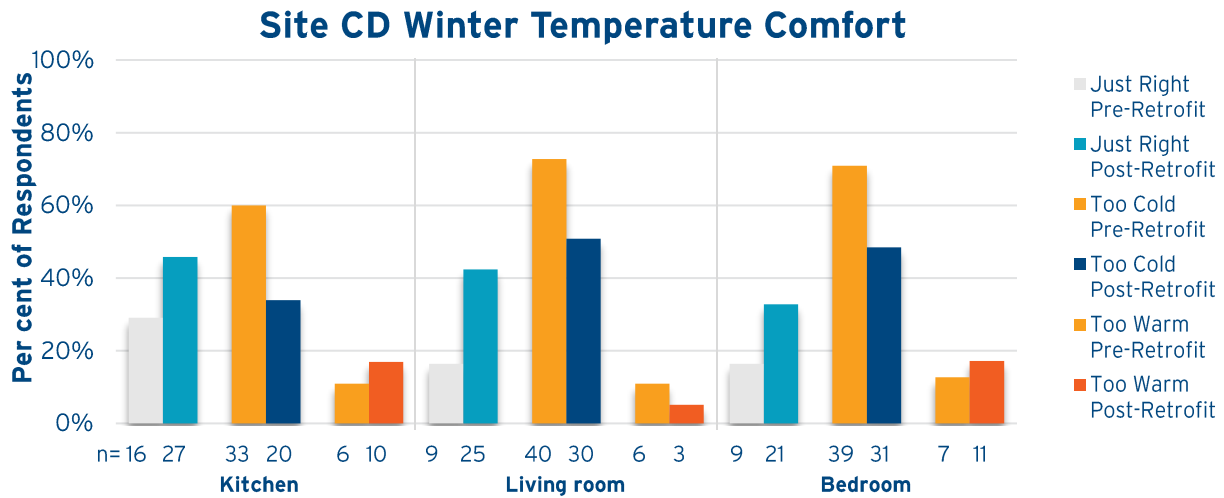
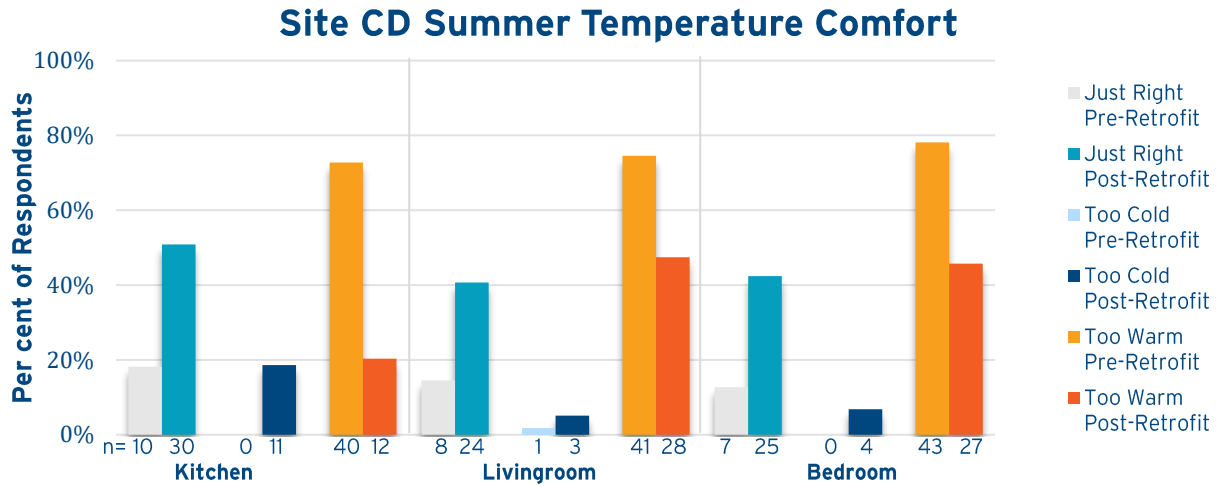
At site CD, “just right” responses were over 1.5 times higher post-retrofit. Although, sites AB and EFG did not see the same level of improvement, “just right” responses on the lower floors of building G did increase (see Appendix C). While perceived winter overheating decreased, perceived under-heating most likely led to the lower “just right” responses at sites AB and EFG..

While the majority of units are bachelor style apartments, the site CD have two and three bedroom units. Therefore temperature consistency in these spaces was of interest. Figure 3, shows the perceived temperature comfort between the different rooms within these multi-bedroom units.

The post-retrofit survey responses at site CD reveal perceived thermal comfort improvements across all rooms. “Just right” responses post-retrofit ranged from 41 - 51 per cent in summer and 33-46 per cent in winter.

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<sup>4</sup> Over the 2017 winter at Building C, only the newly installed condensing boiler was operational, while the two existing boilers were off due to maintenance. This likely had significant impact causing unintended under-heating of the building. See Appendix B for under-heating by site, by floor.

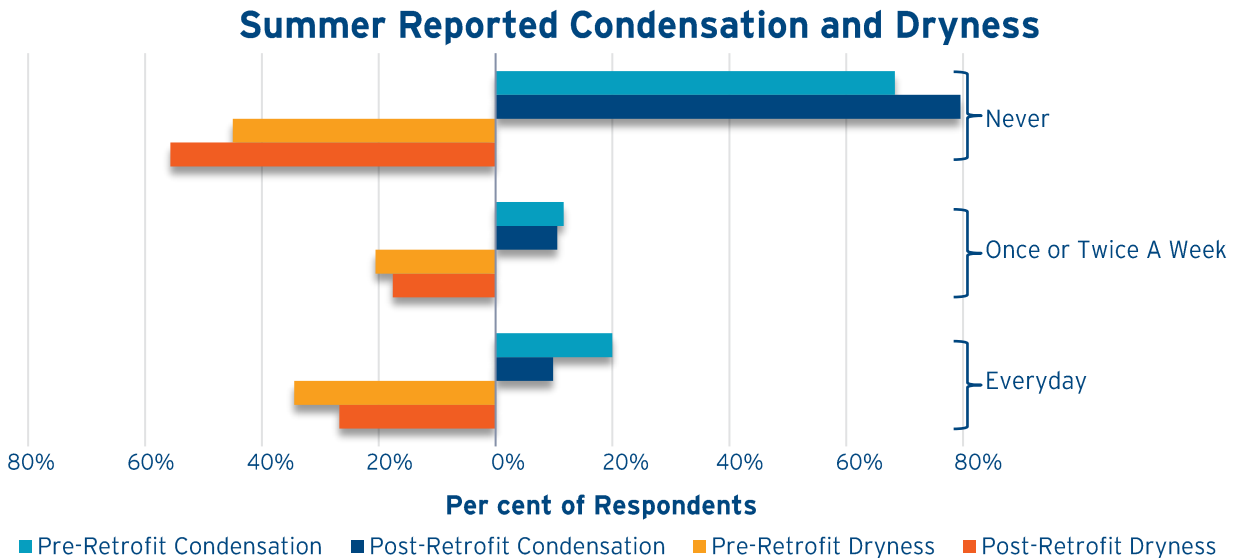
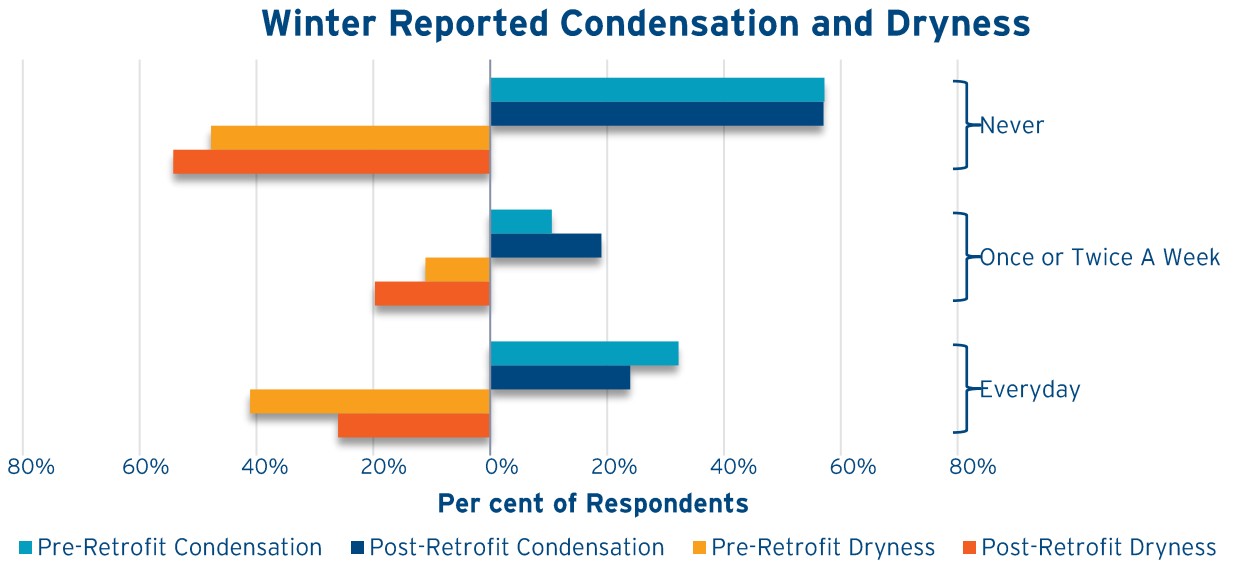


**Figure 3.** Site CD summertime and wintertime comfort by room. N-values represent actual number of responses. “Don’t know” responses are not shown. Summer “don’t know” responses: kitchen 9 per cent (pre), 10 per cent (post); living room 9 per cent (pre), 7 per cent (post); and bedrooms 9 per cent (pre), 5 per cent (post). Winter “don’t know” responses: kitchen 0 per cent (pre), 3 per cent (post); living room 0 per cent (pre), 2 per cent (post); and bedrooms 0 per cent (pre), 2 per cent (post).

Overheating in summer decreased most drastically in the kitchens (73 per cent), followed by the bedrooms (60 per cent), and living rooms (41 per cent). In winter, overheating in the bedrooms and kitchen increased by four to six percentage points while overheating decreased by six percentage points. However, under-heating in winter decreased by as much as 43 per cent across the three types of rooms. This is a positive improvement since 73 per cent of residents had reported feeling cold in their living rooms, pre-retrofit.

### Dryness and Condensation

Relative humidity is also a key component of indoor air quality and can affect the perception of thermal comfort. TAF asked residents whether they experienced excessive dryness or saw signs of condensation throughout the year. Figure 4 shows the results.



**Figure 4.** Summertime and wintertime reported condensation and dryness, across all sites.

Daily instances of reported condensation decreased by 50 per cent during the summer across all sites, while “never” responses increased by 17 per cent, signifying a significant reduction. Although no envelope upgrades were implemented as part of the retrofit process, improving the removal of exhaust air in the bathrooms is likely keeping humidity levels low during the summer. In the winter, instances of daily condensation decreased by 25 percent, and weekly instances increased proportionally. Although these events are still being reported by residents, the shift from daily to weekly reports signifies that they are occurring at a less frequent rate. A reduction of wintertime condensation is largely caused by the reduction of overheating in the units, helping to keep interior conditions above the dew point.

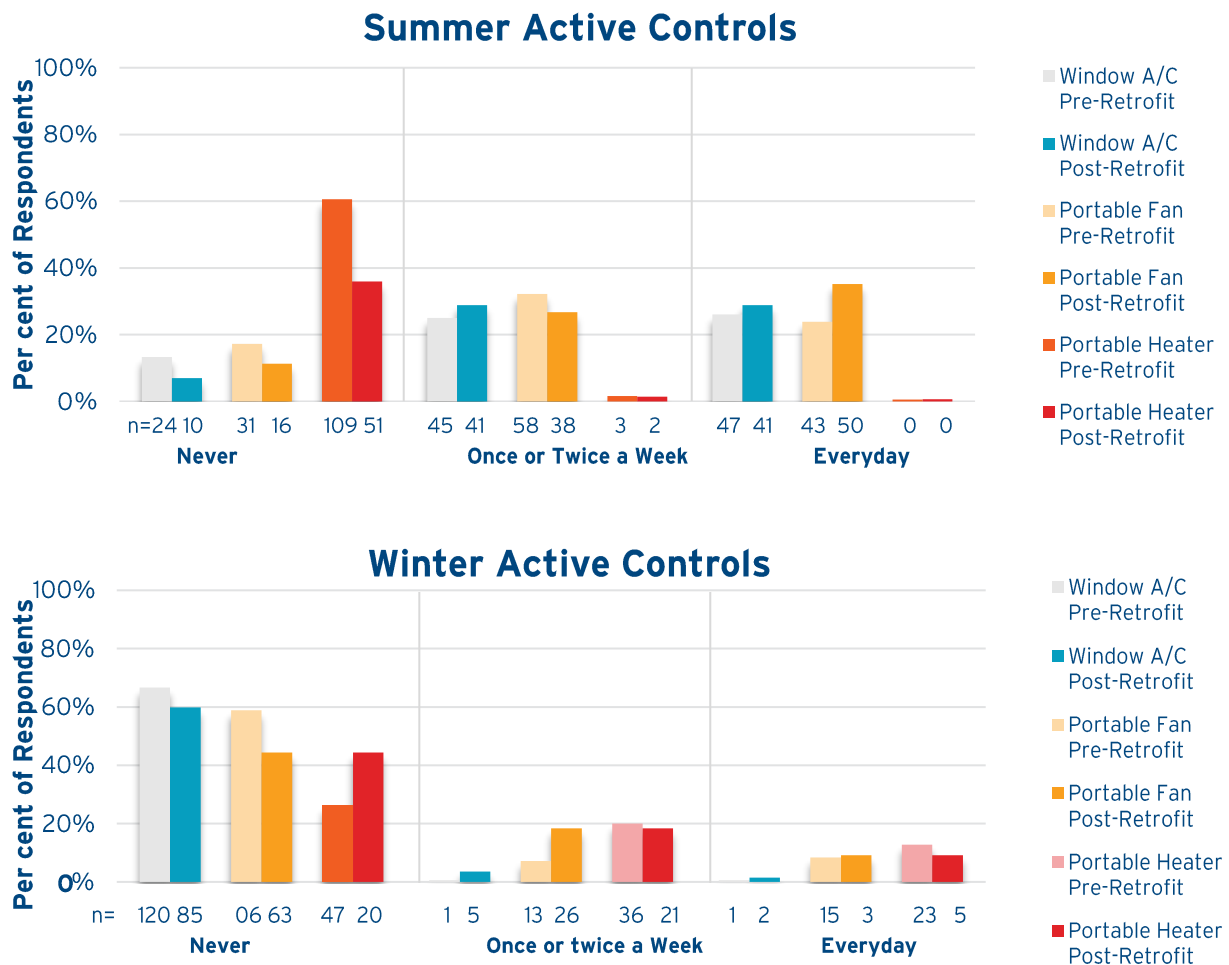
Dryness was reported less frequently during the summer - daily and weekly instances decreased by 20 per cent and 14 per cent, respectively. “Never” responses increased by 24 per cent, indicating that occurrences are becoming less frequent. Daily winter dryness also

decreased, by 37 per cent, while weekly occurrences increased by 81 per cent, and “never” responses increased by 13 per cent. Similar to the condensation trend, reported dryness has not been eliminated, but it is occurring less frequently.

## ACTIVE AND PASSIVE COMFORT CONTROLS

This study evaluated what supplemental heating and cooling controls were used by residents to improve their comfort. Active controls include air conditioning units (window or floor standing models), fans, and portable heaters. Passive controls include opening windows, balcony doors, and hallway doors in order to improve ventilation or help cool down the unit.

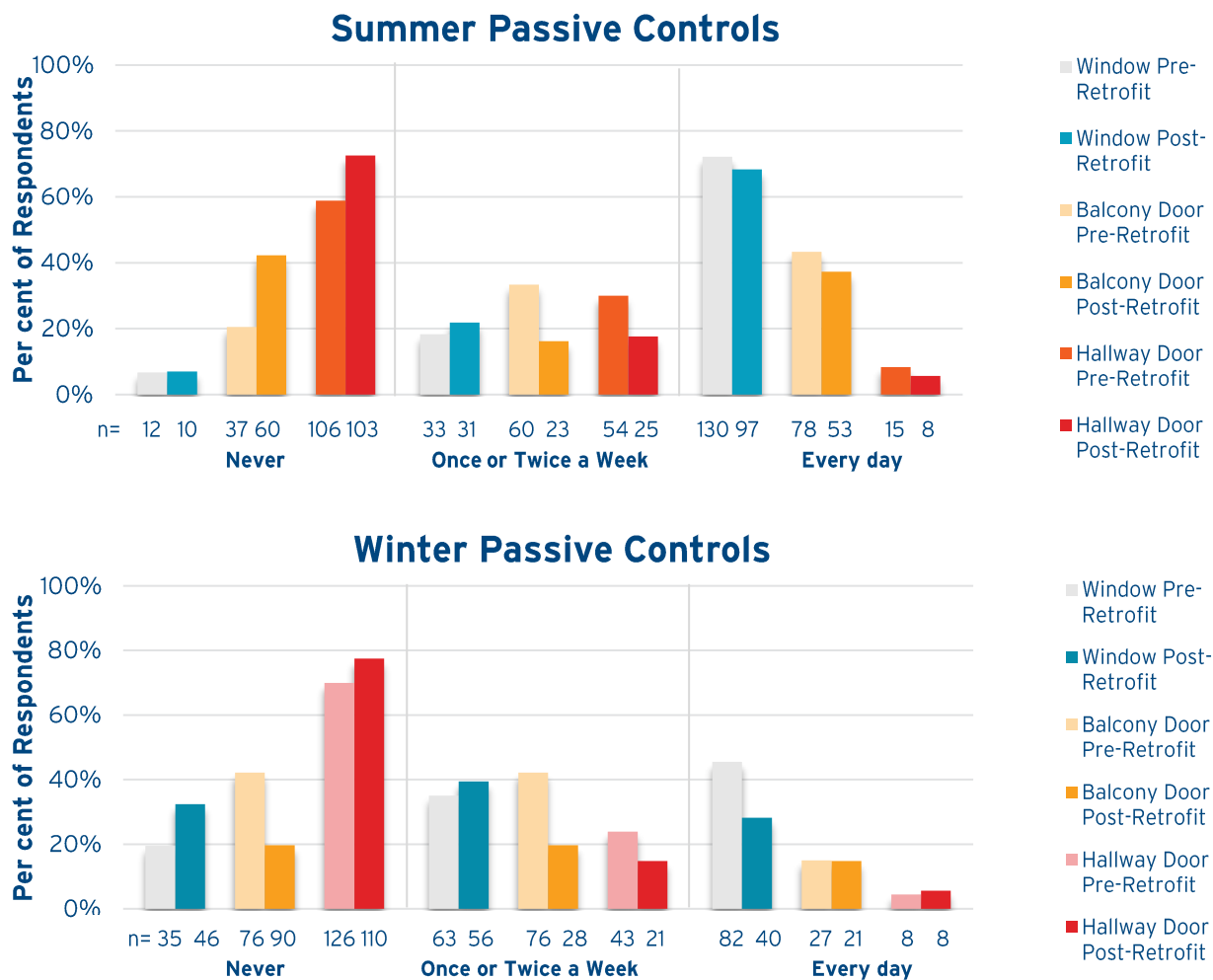
Figure 5 shows a slight increase in use of fans and air conditioners in the summer. Since the 2017 summer was hotter than 2014, the percent of respondents who never used an air conditioner in summer dropped by 46 per cent, while the weekly and daily air conditioner use increased by 16 per cent and 41 per cent, respectively. Installing cooling systems in units was not part of the retrofits, with the exception of site AB where a fresh-air hallway tempering system was implemented.



**Figure 5.** Summer and winter temperature controls. N-values represent actual number of responses. “Don’t know” responses not shown. Summer “don’t know” responses: window A/C 1 per cent (pre), 6 per cent (post); portable fan 1 per cent (pre), 2 per cent (post); portable heater 1 per cent (pre), 6 per cent (post). Winter “don’t know” responses: window A/C 0 per cent (pre), 1 per cent (post); portable fan 1 per cent (pre), 1 per cent (post); portable heater 0 per cent (pre), 3 per cent (post).

In the winter, there was a 69 per cent decrease in portable heater use over pre-retrofit. The use of portable fans on a weekly basis doubled, although there was no significant difference in daily use. The number of respondents who reported they never used an air conditioner decreased by 10 per cent, corresponding to a 4 per cent increase in weekly air conditioner use during the summer. This may simply be due to pre-and-post retrofit surveys capturing slightly different groups of residents as well as a warmer 2017 summer compared to 2014.

Regarding passive conditioning, the post-retrofit survey revealed that a reliance on opening windows and doors for cooling in summer decreased slightly, as shown in Figure 6.

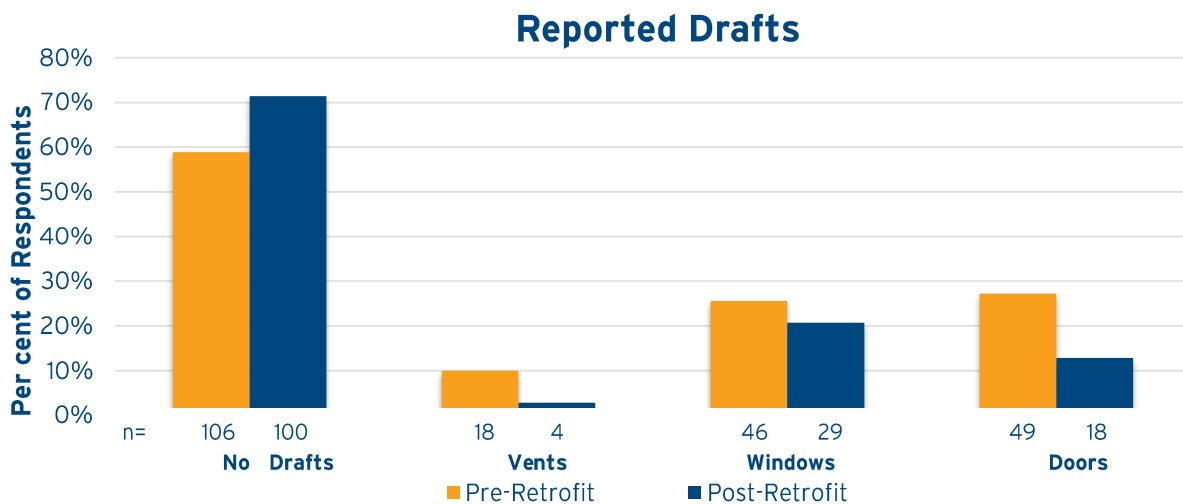


**Figure 6.** Summer and winter passive conditioning. N-values represent actual number of responses. “Don’t know” responses are not shown. Summer “don’t know” values - window 3 per cent (pre), 3 per cent (post); balcony 3 per cent (pre), 4 per cent (post); and hallway 3 per cent (pre), 4 per cent (post). Winter “don’t know” values - window 0 per cent (pre), 0 per cent (post); balcony 1 per cent (pre), 2 per cent (post); and hallway 2 per cent (pre), 2 per cent (post).

During the winter, instances of residents opening their windows every day decreased by 39 per cent post-retrofit, indicating that perceived overheating in units has decreased. Although window opening is occurring, it is less frequent as intended by the implementation of various mechanical system retrofits. Residents may also be opening windows and balcony doors for ventilation, so responses may not reflect changes in thermal comfort alone.

## DRAFTS AND ODOURS

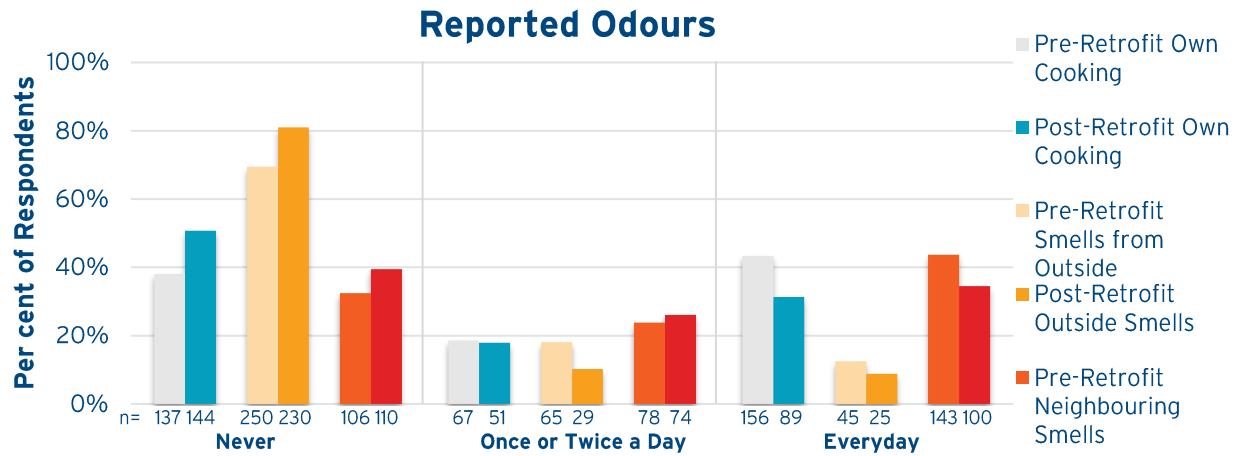
Residents were asked if they experienced drafts around the bathroom exhaust vents, windows, and doors in their unit. Figure 7 shows the type of drafts identified by residents pre-and-post retrofit. Responses indicate that the reported presence of drafts has decreased by 21 per cent across all sites. The largest decreases were around the bathroom exhaust vents (71 per cent), followed by doors (53 per cent), and windows (19 per cent).



**Figure 7.** Drafts pre-and-post retrofit. N-values represent actual number of responses. “Don’t know” responses are not shown: 3 per cent (pre) and 1 per cent (post).

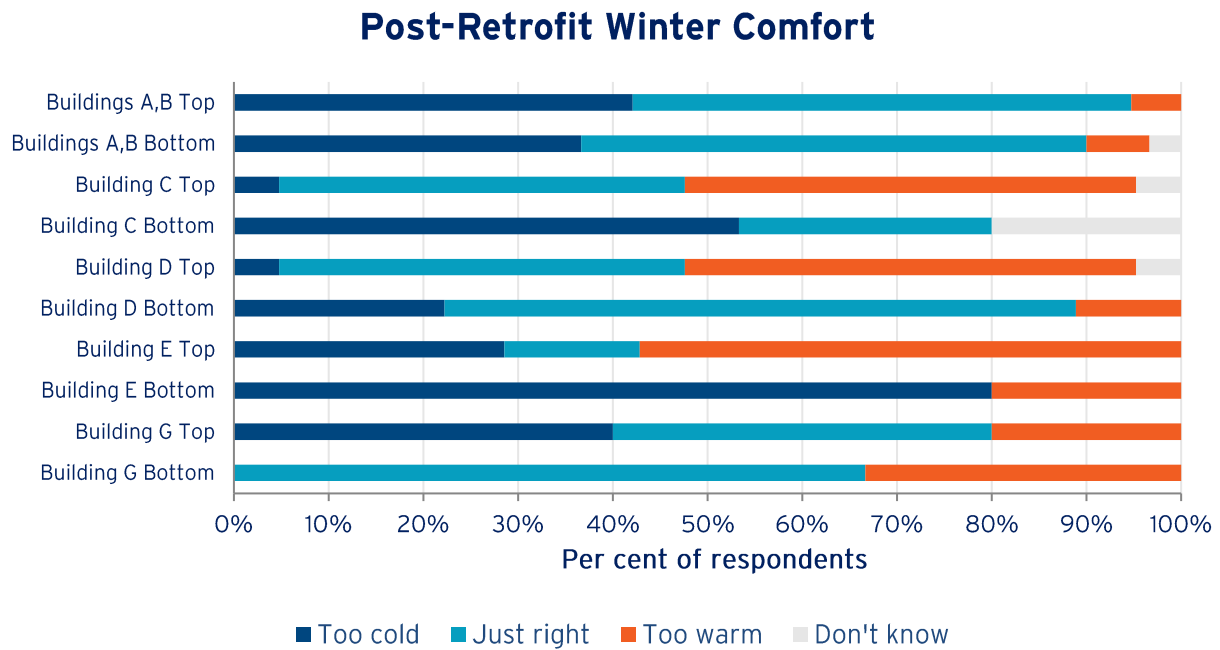
Another facet of indoor air quality is exposure to odours. Multi-residential buildings with central ventilation systems commonly experience the transfer of odours between units. Due to increased corridor pressurization, we believe this odour transfer has decreased. Figure 7 shows the types of odour exposures residents have experienced pre-and-post retrofit.

Post-retrofit instances of daily reported odours decreased for all three types: neighbouring odours (31 per cent less), own cooking odours (28 per cent less), and outside odours (20 per cent less). There is also a relatively proportional increase of “never” responses. Instances of weekly reported odours did not change consistently; they remained similar at site AB, decreased at site EFG, and increased slightly at site CD. These findings indicate that reported odours have not been eliminated at the sites, but rather, the frequency of reported problems has decreased.



**Figure 8.** Pre-and-post retrofit reports of odours, averaged across all seasons. N-values represent combined responses for summertime and wintertime odours.

In the pre-retrofit survey, residents raised concerns about their health and exposure to second hand smoke, asthma, etc. due to smoke infiltration.

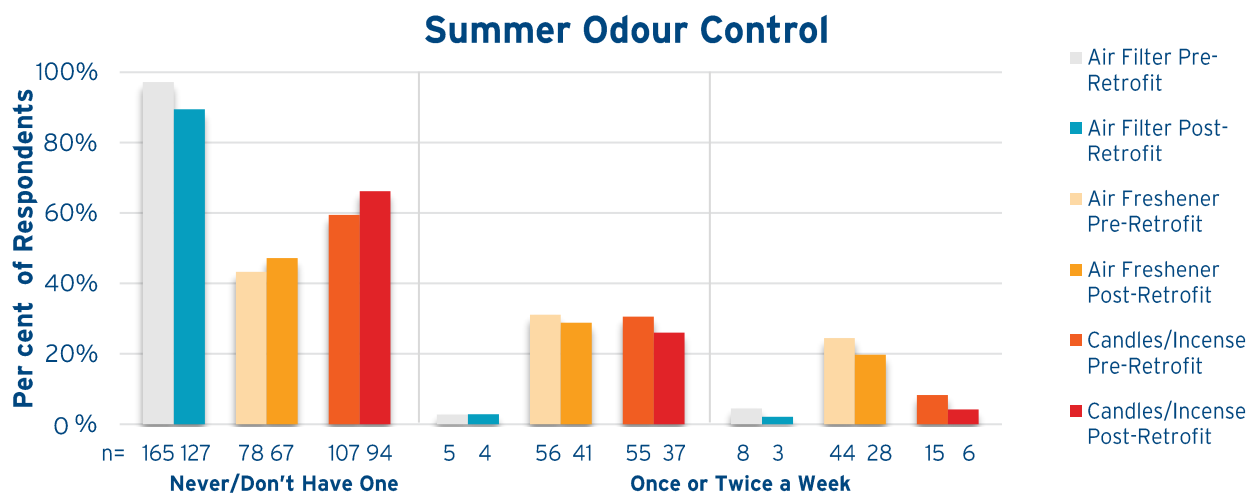


Appendix D provides an overview of these concerns for pre-and-post retrofit surveys. An overall trend towards a decrease of neighbouring odour can be seen, based on fewer post-retrofit survey complaints surrounding the intrusion of smoke or odours from neighbouring apartments.

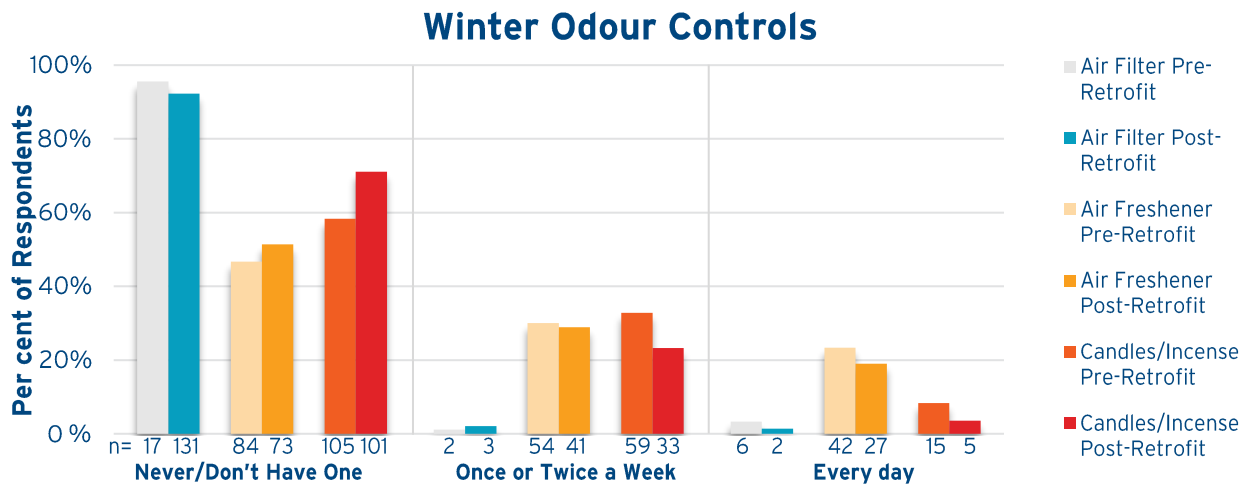
## Odour Controls

This section examines the use of odour controls, such as air filters, air fresheners, and products like candles, incense, or oil.

Figure 9 shows the pre-and-post retrofit use of various odour control strategies. Post-retrofit, the summer daily use of all types of odour control strategies decreased: air filtering by 50 per cent, air-freshener use by 16 per cent, and candle/incense use by 50 per cent. This is also true for weekly use, with the exception of weekly air-filtering, which showed no change. Winter showed similar trends: air-filtering decrease by 67 per cent, air-freshener use by 17 per cent, and candle/incense use by 50 per cent. It is important to note while these reductions are large, very few residents used these odor control strategies to begin with. Summer and winter responses of not having or not using air filters decreased by eight per cent and four per cent, respectively, possibly indicating a shift in behaviour or need to rely on such systems.







**Figure 9.** Summer and winter odour control. N-values represent actual number of responses. “Don’t know” responses are not shown: 0 per cent (pre) and 4 per cent (post) air filters; 0 per cent (pre) and 1 per cent (post) air fresheners, 1 per cent (pre) and 3 per cent (post) candles/incense.

## HEALTH OUTCOMES

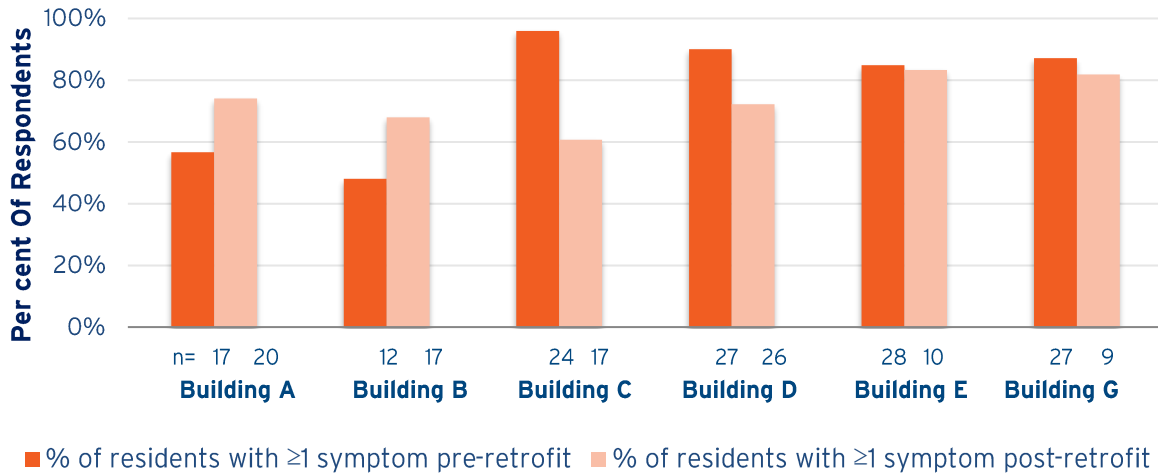
Residents were asked to identify how often they experienced the following symptoms, which are common indicators of poor IEQ:

- fatigue, tiredness, exhaustion
- headache
- itching, burning, irritation of eyes
- irritated, stuffy or runny nose
- hoarseness, dry throat
- cough
- dry or flushed skin on the face

Figure 10 shows pre-and-post retrofit symptoms by building<sup>5</sup>. Post-retrofit, there was a 28-57 per cent decrease in the frequency of symptoms occurring “every few days” across all symptoms. Occasional experience of symptoms also decreased, on average, with exception of “irritated, stuffy or runny nose” and “dry or flushed skin on the face”, which increased by 15-18 per cent, respectively. In relation to these reductions, “never” responses increased by 9-42 per cent, on average. Overall, there is a decrease in symptoms associated with poor IEQ, which is consistent with the project goals.

<sup>5</sup> Building F has been left out of this section, as the sample size was too small to draw clear conclusions (6 units pre-retrofit, 3 units post-retrofit).

## Residents with at least one symptom



**Figure 10.** Per cent of residents reporting more than one symptom. N-values represent actual number of responses.

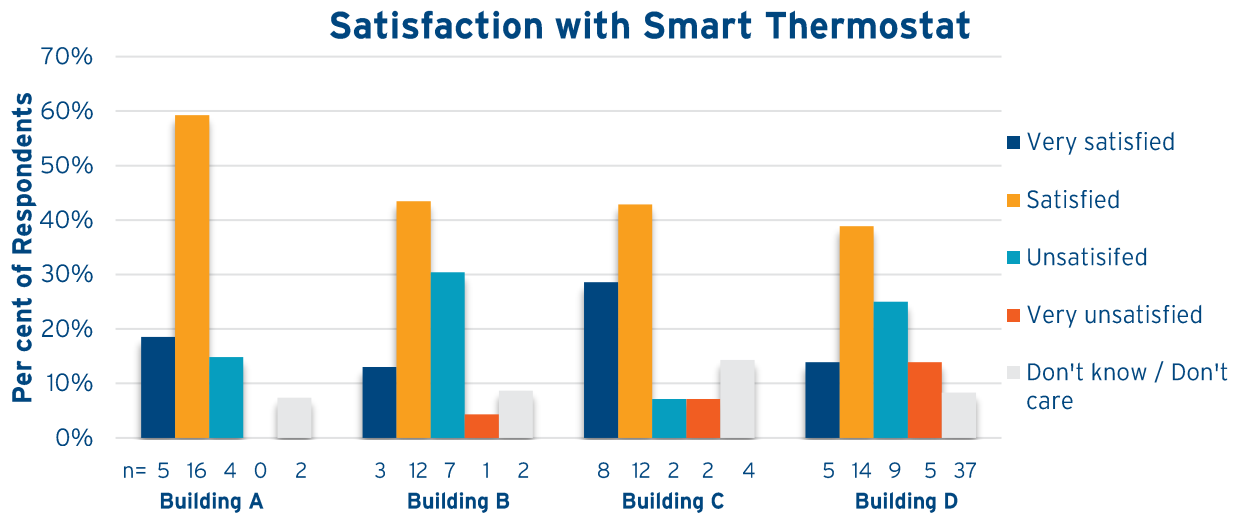
Residents were also asked how many times they had missed school or work within the past three months due to illness. At site CD, where the highest percentage of children and adults leave to attend work/school, absences due to illness decreased by 81 per cent and 35 per cent, respectively.

Residents were also asked how many hospital visits they had made over three months preceding the pre-and-post retrofit surveys. Reported hospital visits decreased by an average of 37 per cent across sites AB and CD; however, site EFG saw a 69 per cent increase. While the survey responses on health outcomes provide interesting data, it is important to note that a comprehensive health assessment was not part of this study. Therefore, any increases or decreases in health symptoms can be due to other external factors, not related to the energy retrofits implemented.

## IN-SUITE SMART THERMOSTATS

TAF installed over 700 smart thermostats across sites AB and CD. The thermostats control the baseboard radiators in each unit, providing residents with individual heating control over their units. The majority of thermostats have an upper temperature limit of 24°C; however in cases of medical concerns, upper limits were programmed to 25°C.

Figure 11 shows that, on average, 65 per cent of residents were either satisfied or very satisfied with their smart thermostats. Residents at building A were generally more satisfied (60 per cent satisfied, 19 per cent very satisfied) with the thermostats than at building B. Residents at building C had the highest number of very satisfied responses, equal to 29 per cent of respondents.

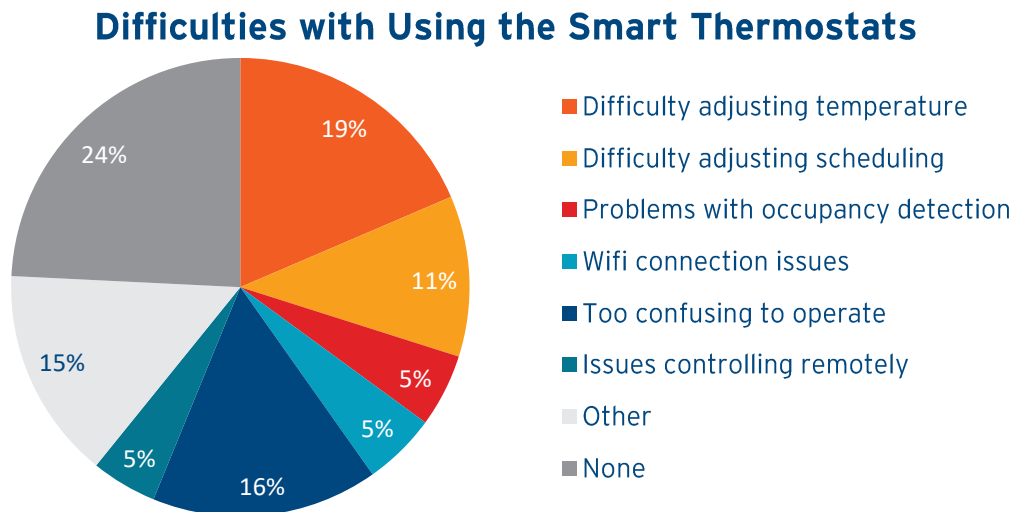


**Figure 11.** Resident satisfaction with smart thermostats. N-values represent actual number of responses.

TAF also asked residents if they had any difficulties using their smart thermostats. Responses indicated that 33 per cent of residents at site AB and 19 per cent of residents at site CD had no difficulties with the controls.

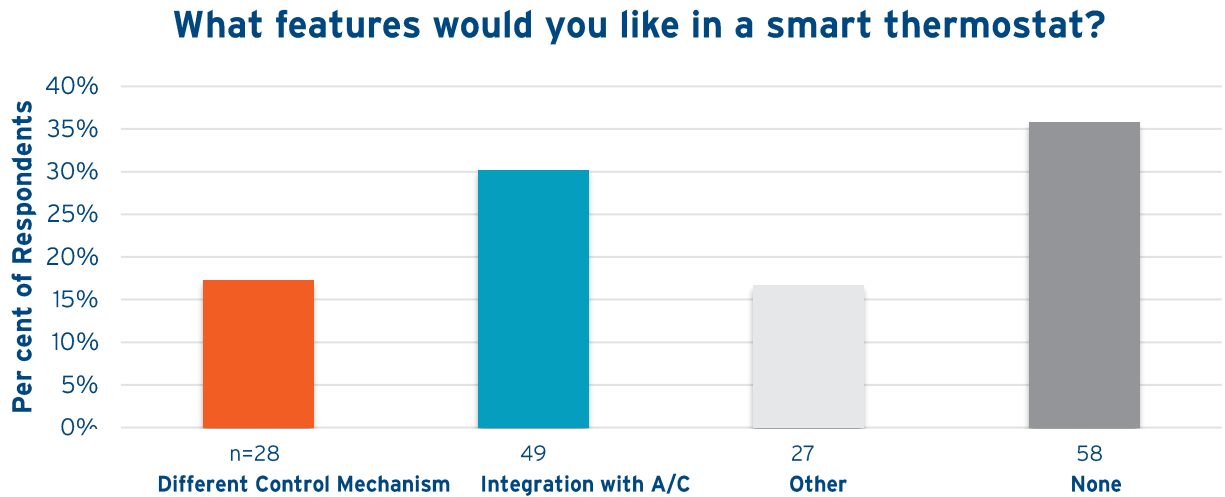
For residents that had difficulties using the thermostats, similar responses were grouped in specific categories and are shown in Figure 12. The largest concerns were that residents found it difficult to adjust the temperature (19 per cent), or found the thermostats too confusing to operate (16 per cent). The 'other' category (15 per cent) included initial troubles in learning how to use these controls that were later resolved. Many responses also reflected a "set it and forget it" attitude, indicating that residents did not interact with the thermostat often.

There was little difference in concerns between sites AB and CD, with the exception that at site CD more residents found it difficult to adjust the scheduling. Based on interactions over the past year, TAF has seen very few residents at site AB use the scheduling function, which is likely why residents did not report it as a concern.



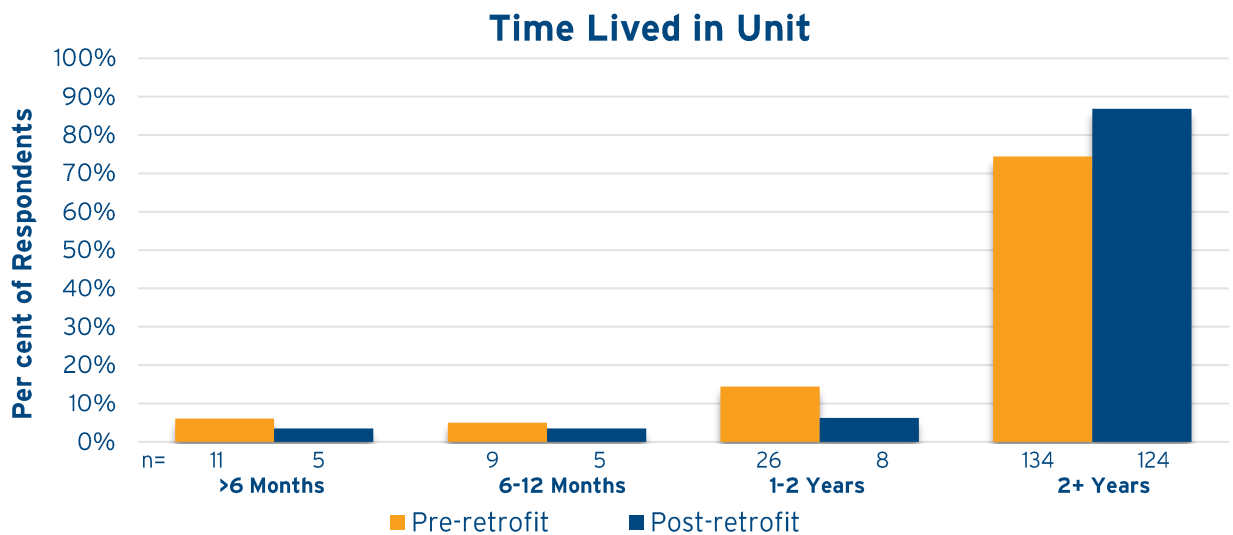
**Figure 12.** Difficulties with using the smart thermostats, across both sites.

Figure 13 shows the additional features residents would like to see on their smart thermostats. The most popular requested addition was integration with air conditioners (30 per cent), followed by different control mechanisms (17 per cent). It is important to note that 36 per cent of residents did not want any additional features.

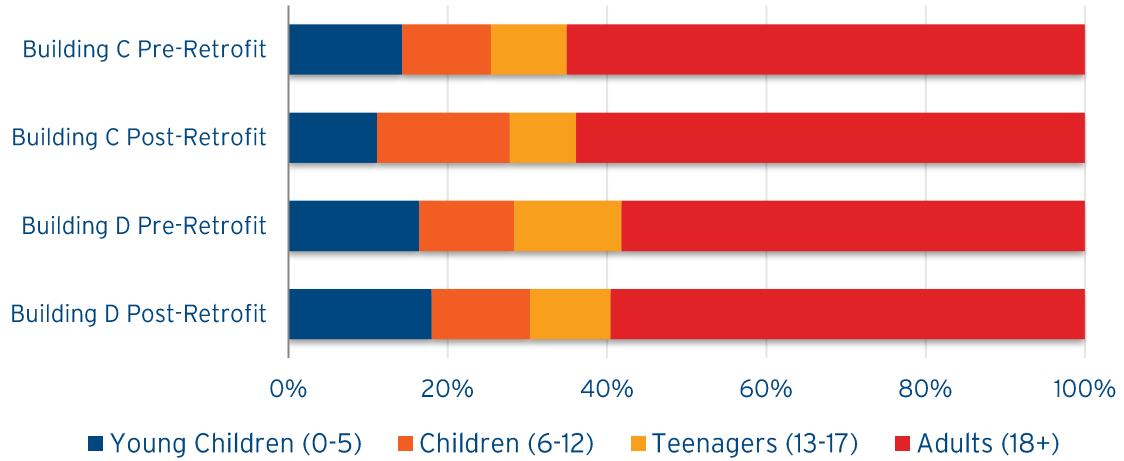


**Figure 13.** Additional smart thermostat features. N-values represent actual number of responses.

## APPENDIX A - DEMOGRAPHICS

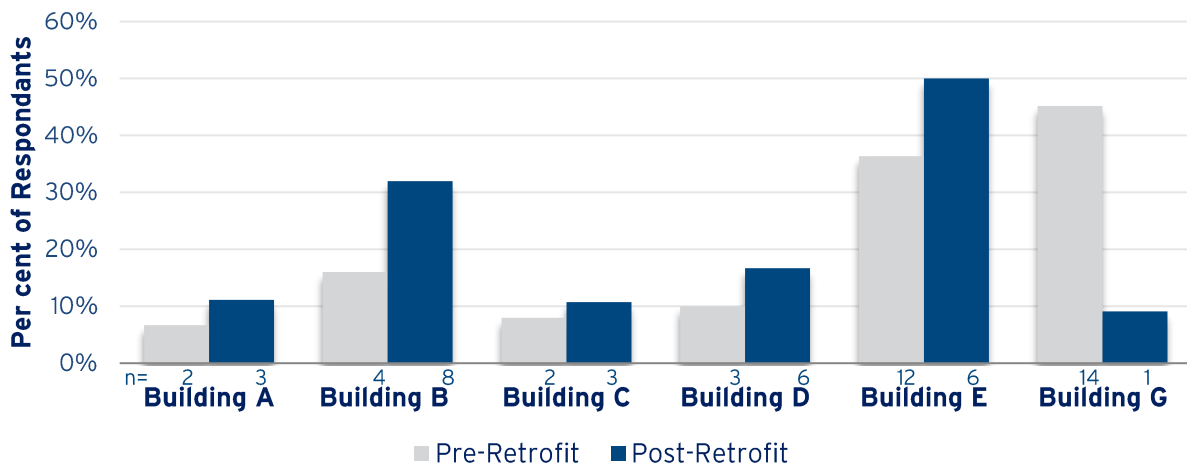


### Site CD Resident Demographics by Age



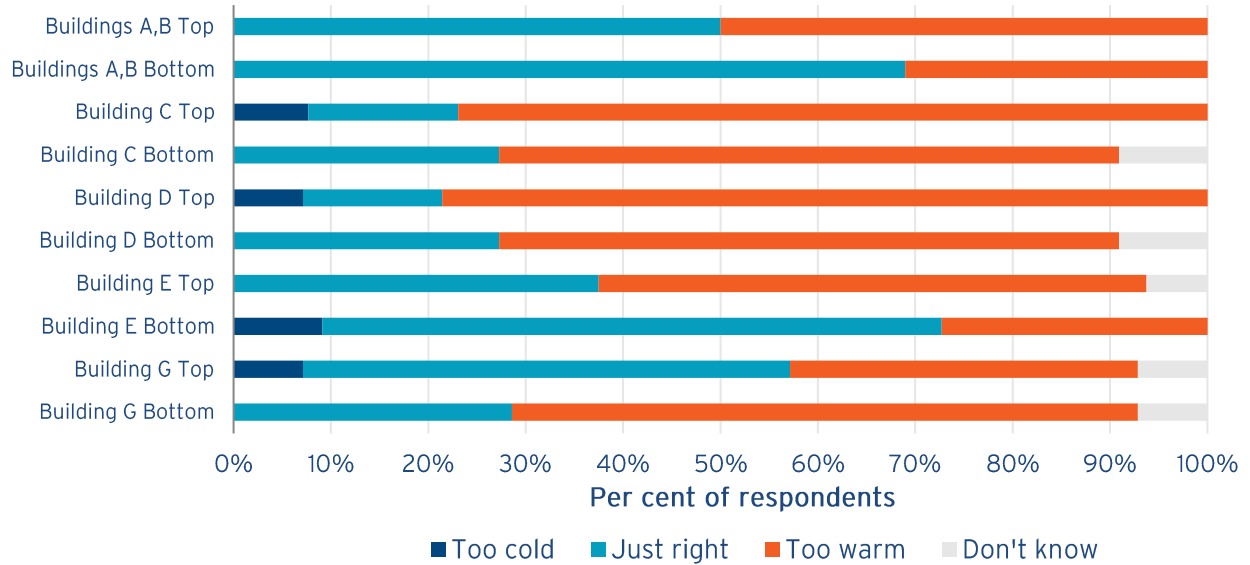
### APPENDIX B - DEMOGRAPHICS cont.

#### Pre-Retrofit & Post-Retrofit Smoking

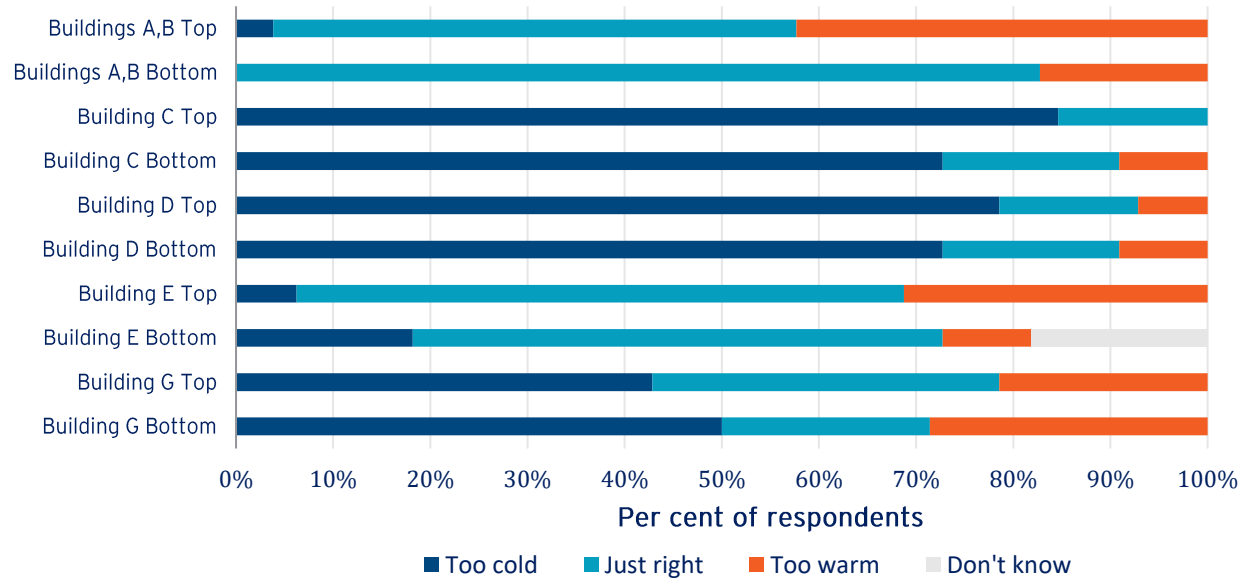


## APPENDIX C - THERMAL COMFORT BY BUILDING AND FLOOR

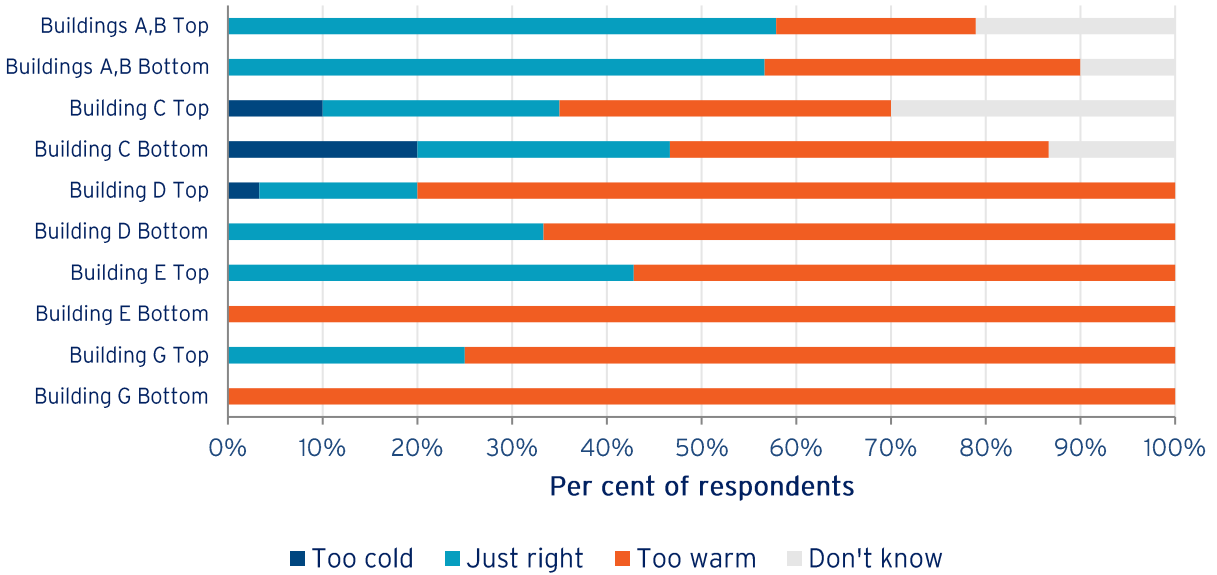
### Pre-Retrofit Summer Comfort



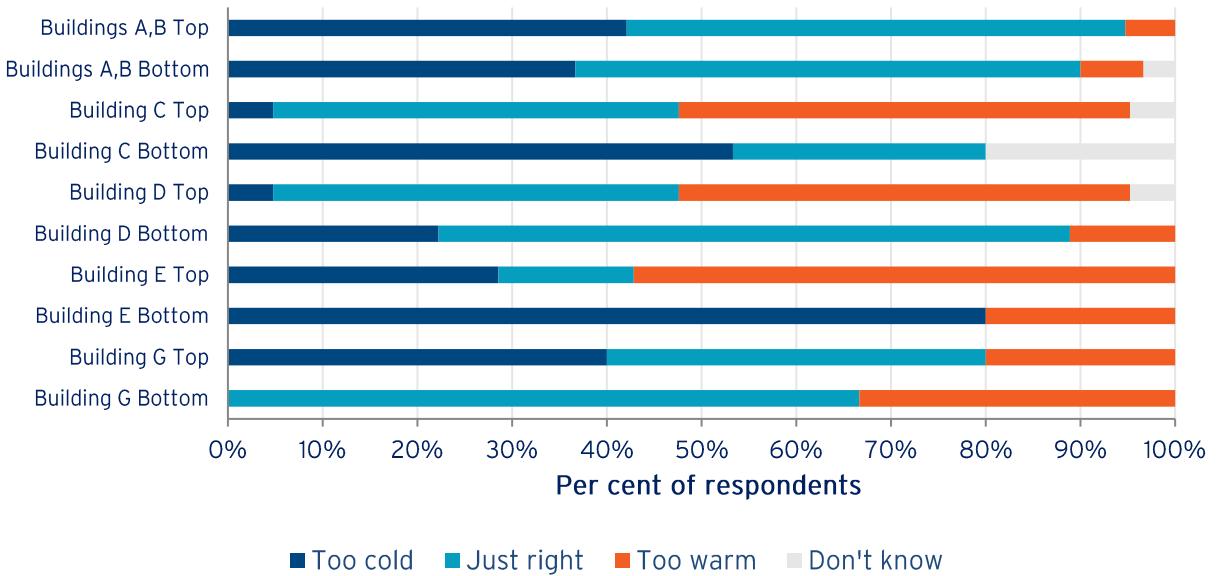
### Pre-Retrofit Winter Comfort



## Post-Retrofit Summer Comfort



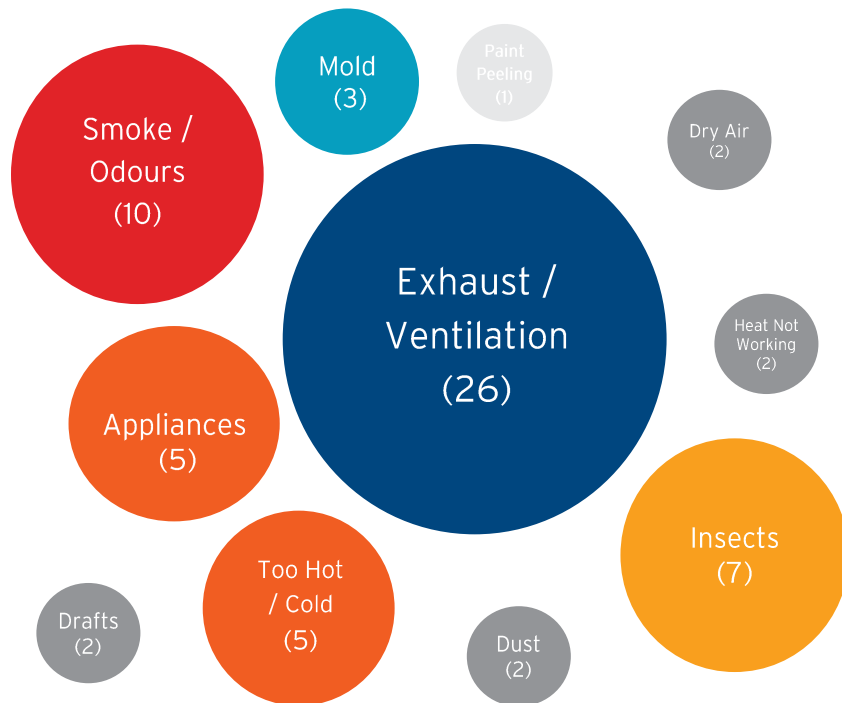
## Post-Retrofit Winter Comfort



## APPENDIX D - RESIDENT CONCERNS REGARDING SUITES

In an open-ended question towards the end of the survey, residents were asked if they had any remaining concerns regarding their units which were not covered by earlier questions. The following responses were most common:

### Pre-Retrofit Concerns



### Post-Retrofit Concerns

