



Customer-Led Network  
Revolution

## Heat Pump Survey Results

### July 2014 Social Science Team Report

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## 1. Introduction

As part of the CLNR project, trial participants who had had a heat pump installed were contacted via telephone by British Gas and asked to take part in a telephone survey. This report provides an overview of the responses received from 120 participants from Test Cell 3.

The heat pump survey was designed to investigate customer experiences of the transition to the new heating system. This included the effects of the new system on temperature set points and the number of rooms being heated in the home, as well as how the customers experienced the changeover. Customers were also asked to reflect on how well they understood the new system and how confident they were in interacting with the new heat pump compared to their previous heating system. These questions were designed to identify patterns of user confidence, understanding and heating regimes across socio-demographic groups. The survey also enables integrated analysis of energy use data and these variables.

## 2. Sample Description

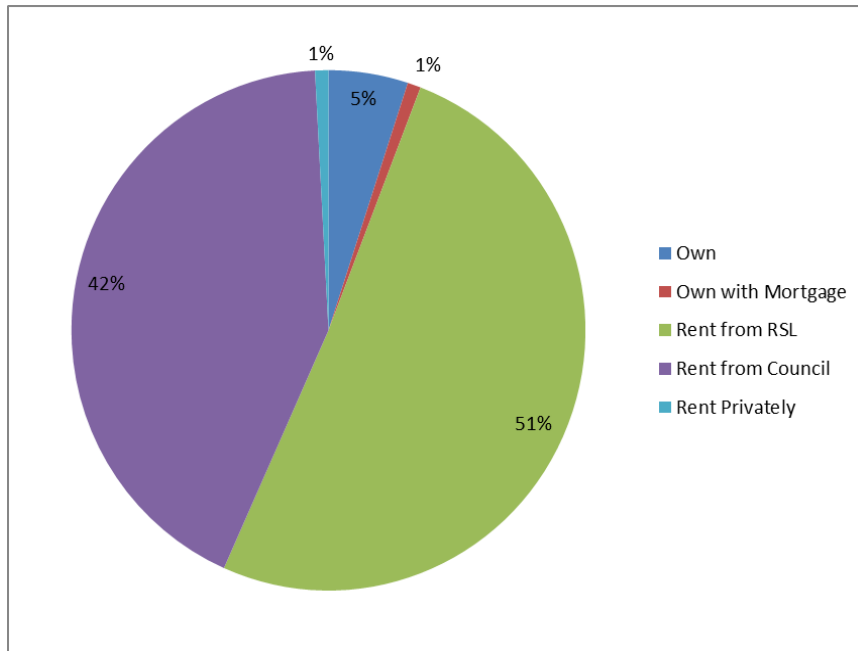
120 people completed the survey. We describe here their socio-demographic characteristics in this section of the report.

### 2.1 Tenure

Housing Tenure	n
Own	6
Own with Mortgage	1
Rent from RSL <sup>1</sup>	61
Rent from Council	51
Rent Privately	1

<sup>1</sup> Registered Social Landlord

**Figure 1: Tenure**



## 2.2 Age

Age Group	n
Under 26	4
26 to 35	7
36 to 45	9
46 to 55	11
56 to 65	27
66 or Over	60
NA's	2

**Figure 2: Respondent Age**

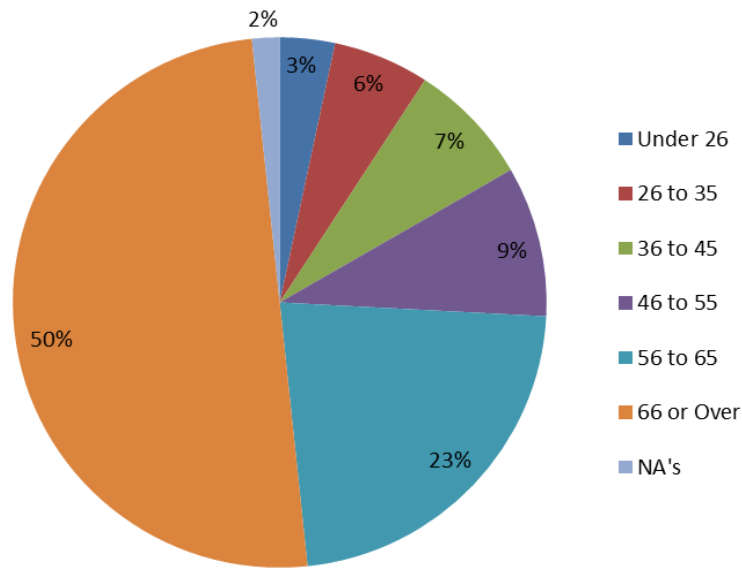
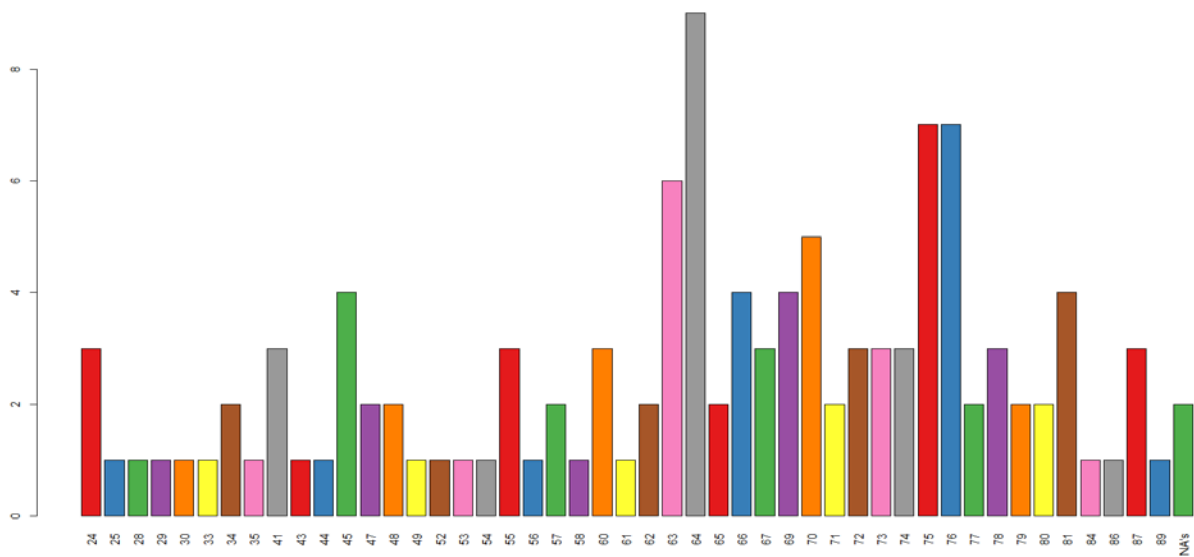


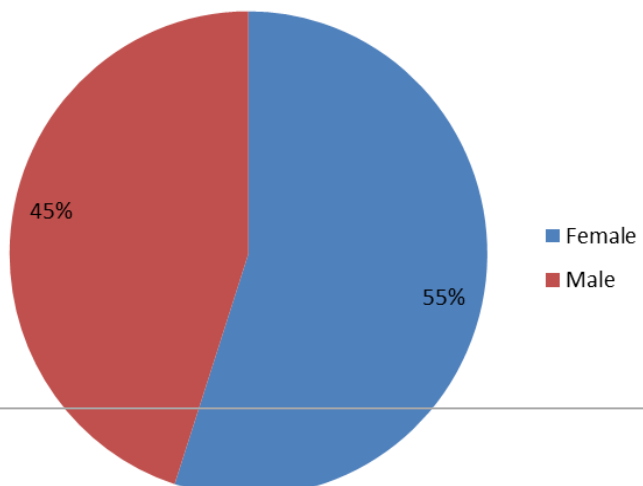
Figure 3: Respondent Age



### 2.3 Gender

Gender	n
Female	66
Male	54

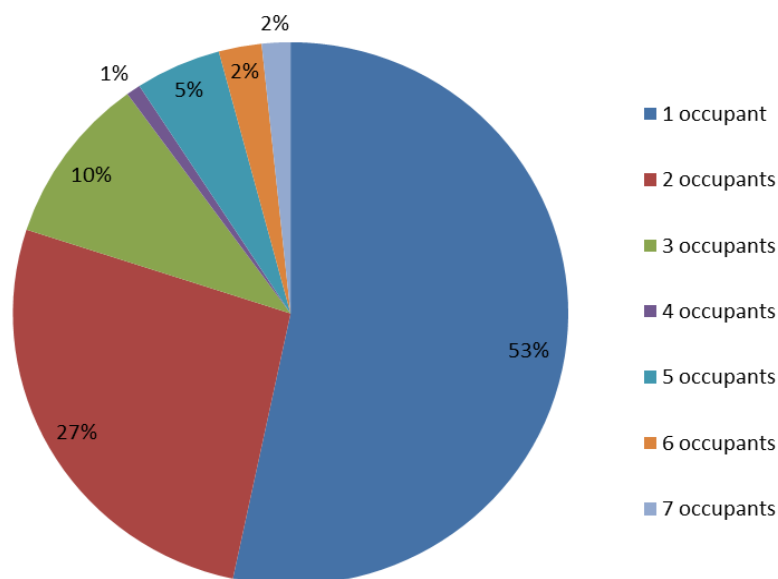
Figure 4: Gender



## 2.4 Occupancy

Number of people in the home	n
1	64
2	32
3	12
4	1
5	6
6	3
7	2

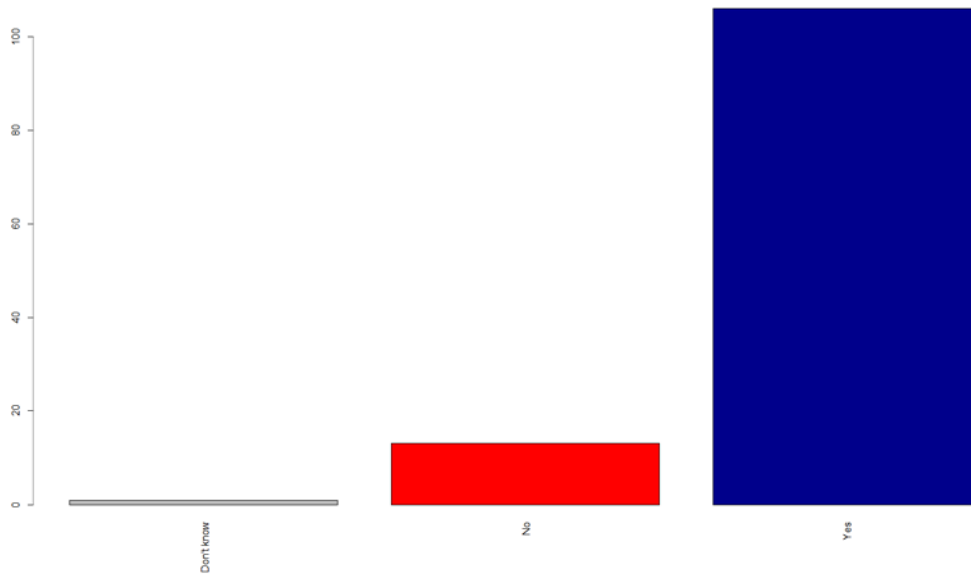
Figure 5: Number of Occupants



## 2.5 Presence of Someone Not in Employment, Education or Training

Is anyone living at the property not in employment, education or training?	n
Don't know	1
No	13
Yes	106

Figure 6: Presence of Someone NEET



### 3. The Impacts of the Heat Pumps

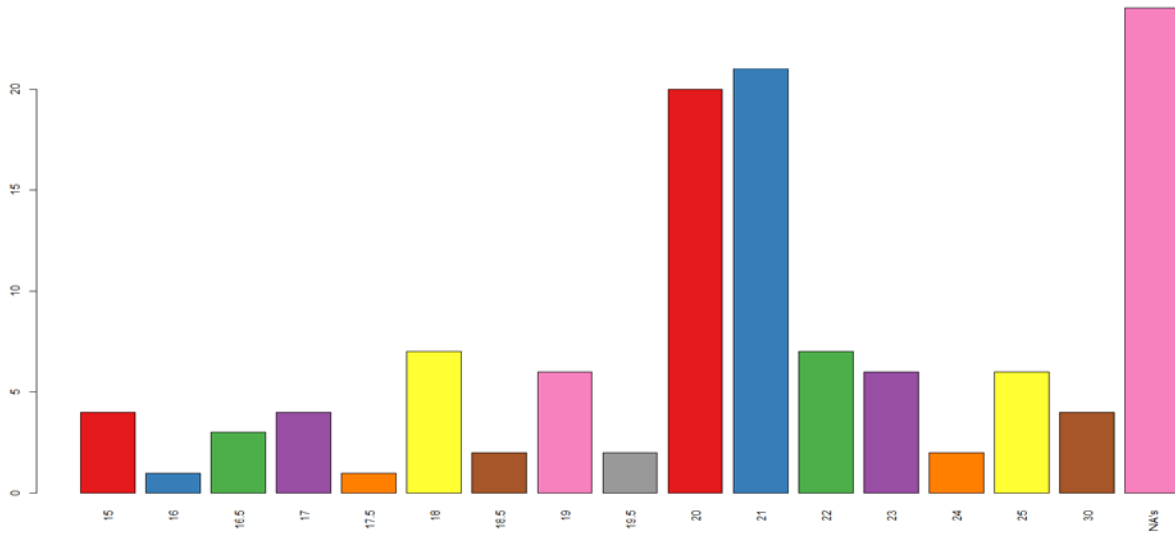
#### 3.1 Set Point

Participants were asked to indicate the set point at which their heat pump system is working to. Results show that while 20 and 21 degrees are the most commonly reported temperatures there is a minority of people who have their system set to very high and very



low temperatures which will have impacts for both the health and financial wellbeing of the participants as well as the operating efficiency of the systems.

**Figure 7: Reported Indoor Set Point for Heat Pump Systems**



Set Point	n
15	4
16	1
16.5	3
17	4
17.5	1
18	7
18.5	2
19	6
19.5	2
20	20
21	21
22	7
23	6
24	2
25	6
30	4
NA's	24

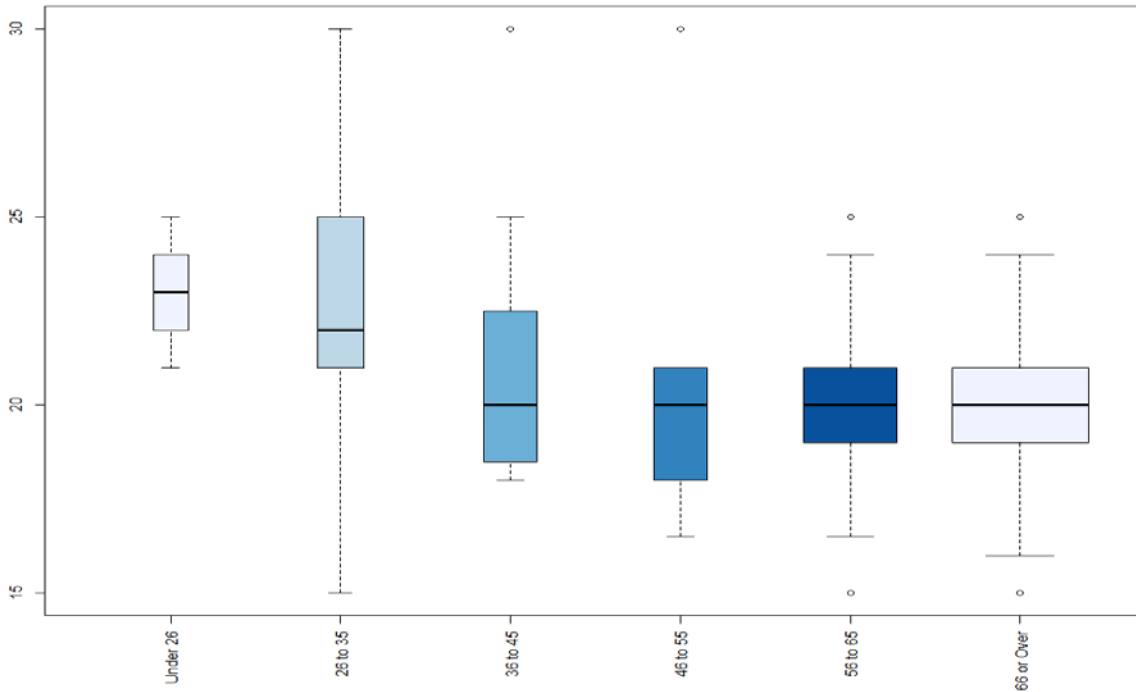
We can compare the average system set points use by groups of customers by splitting the sample socio-demographically.

**3.1.1 Set Point and Age Group**

In our sample younger respondents reported using higher set points, as illustrated below. However, the difference between the age groups was not statistically significant (ANOVA test

returns  $p=0.296$ ). None-the-less, this raises issues about the energy demand of future and emerging heating practices.

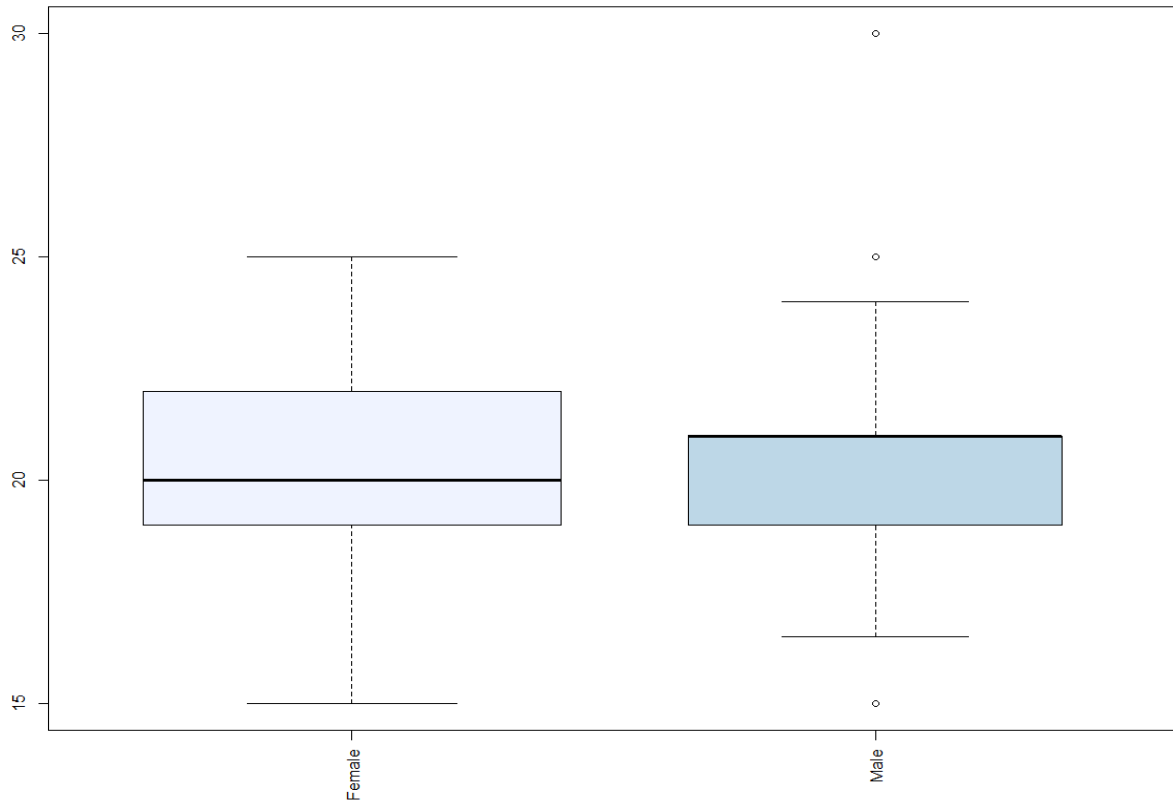
Figure 8: System Set Point by Age Group



### 3.1.2 Set Point and Gender

The chart below shows that set –points used by men and women are similar, although the average set point for men (20.92 °C) is higher than for women (20.22 °C) in our sample. These differences are not statistically significant ( $p=0.279$ ).

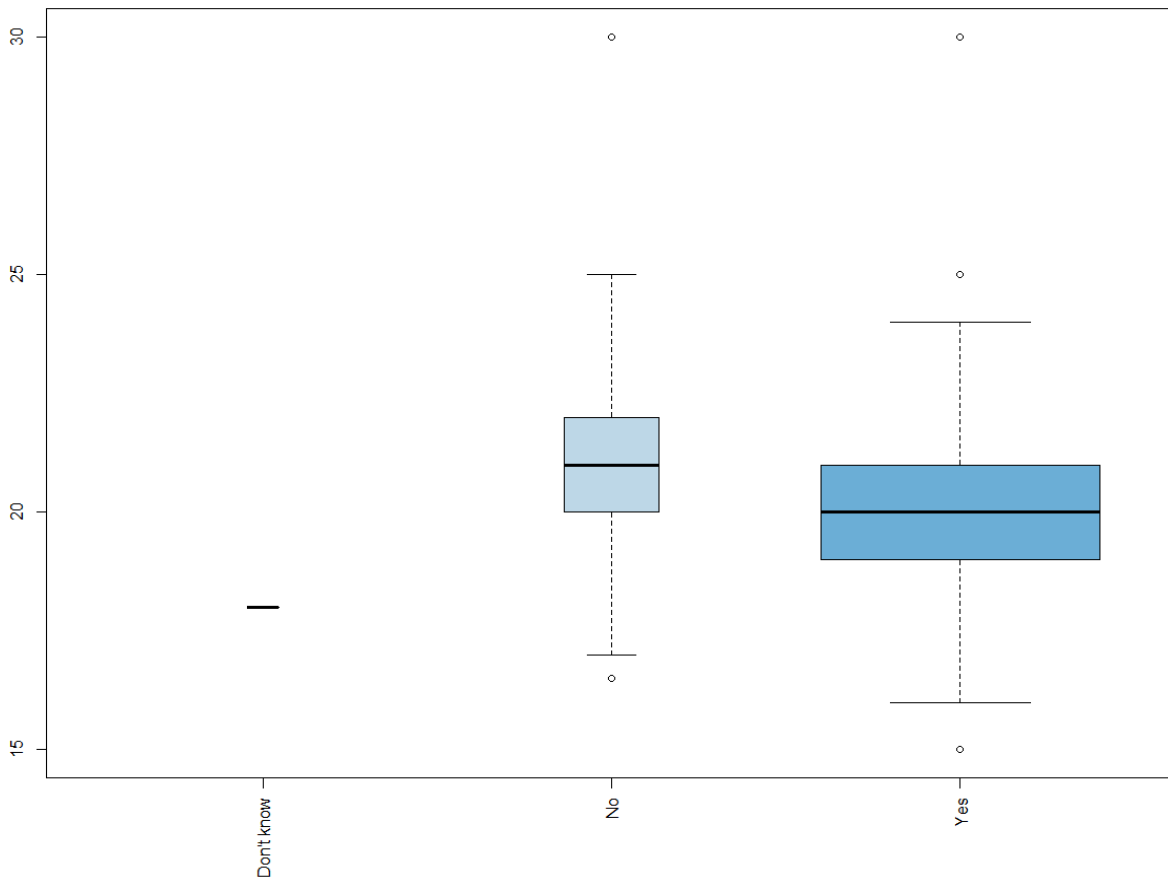
Figure 9: System Set Point by Gender



### 3.1.3 Set Point and Presence of Someone Not in Employment, Education or Training

We can see in the chart below that system set point is lower for those with someone not in employment, education or training, with average set point being 21.39DegC for those without someone not in employment, education or training and 20.47 for those with someone not in employment, education or training. While this difference between average set points is not statistically significant however (ANOVA returns  $p=0.479$ ).

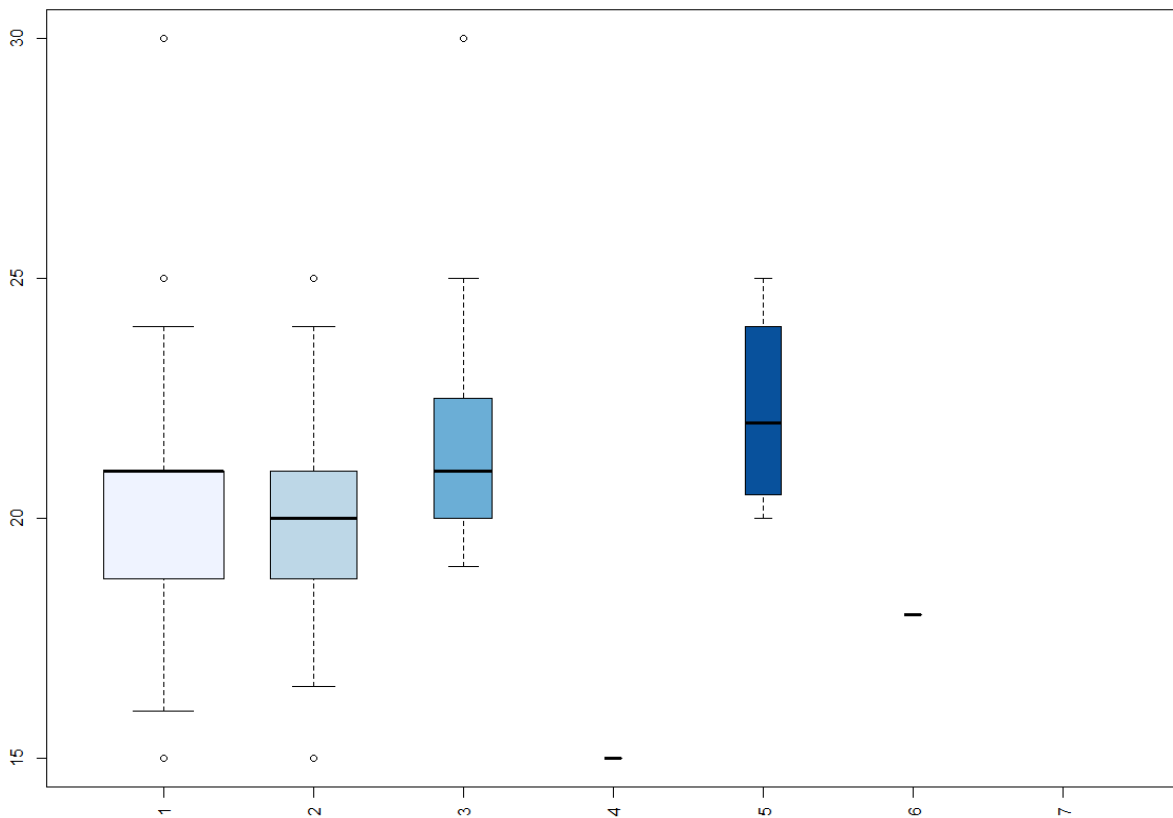
Figure 10: System Set Point by Presence of Someone NEET



### 3.1.4 Set Point and Occupancy

While the chart makes clear in our sample households with fewer occupants had lower set points, the difference between average set points between groups is not statistically significant (ANOVA returns  $p=0.138$ ). This is likely to be because there were relatively few large households in this sample (12 respondents had households of four for more people) and suggests that the difference in average set point between households of different sizes may further attention in future studies.

Figure 11: System Set Point by Number of Occupants

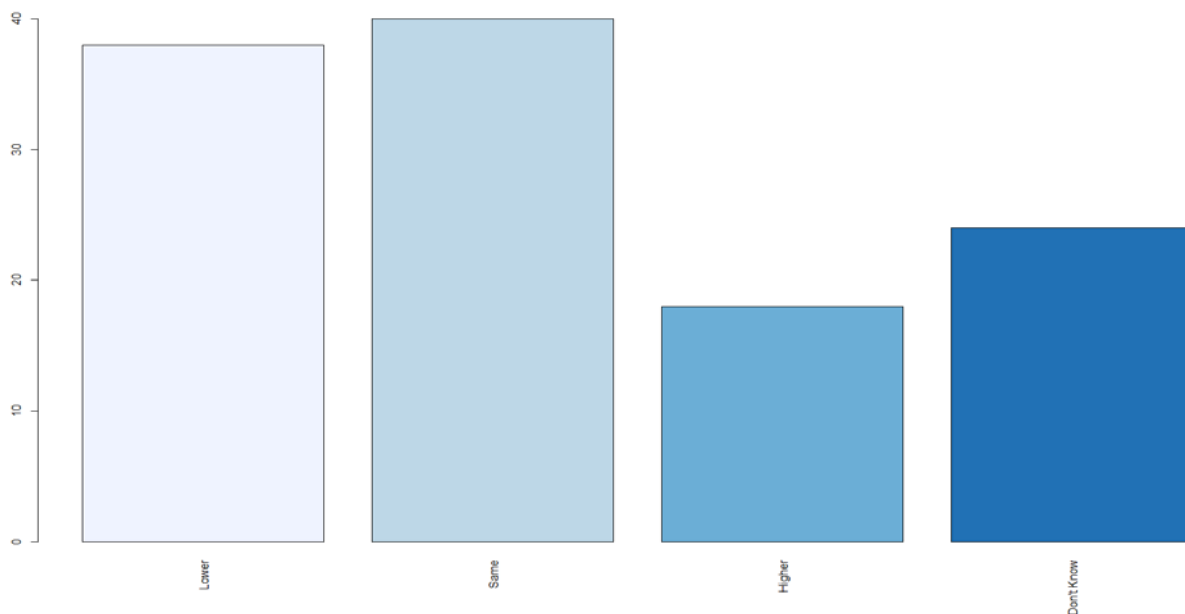


### 3.2 Change in Set Points

People were asked whether the temperature at which they set their heating systems had risen, fallen or stayed the same after having the heat pump installed. The results show that the most common answer was that it stayed the same but more than twice as many people reported a lower set point (38 people) than a higher one (18 people). It also reveals that many people (24 / 120) did not know what their set point was either before or after the heat pump was installed, or both.

Set Point	n
Lower	38
Same	40
Higher	18
Don't Know	24

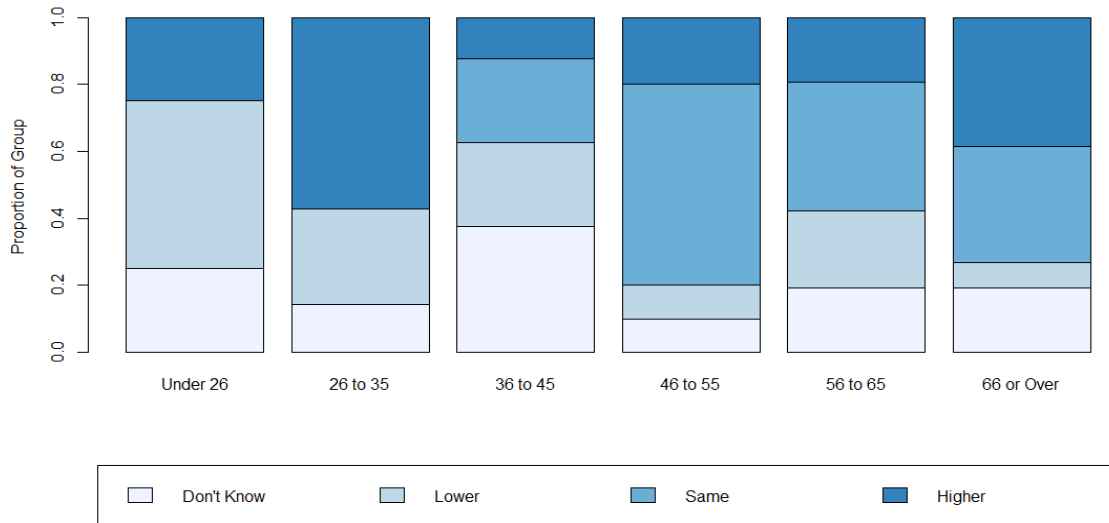
Figure 12: Increase or Decrease in Heating Set Point



It is possible to analyse how different groups of participants changed their set point after the installation of a heat pump by comparing between the socio-demographic groups.

### 3.2.1 Change in Set Point by Age Group

Figure 13: Set Point Change by Age Group

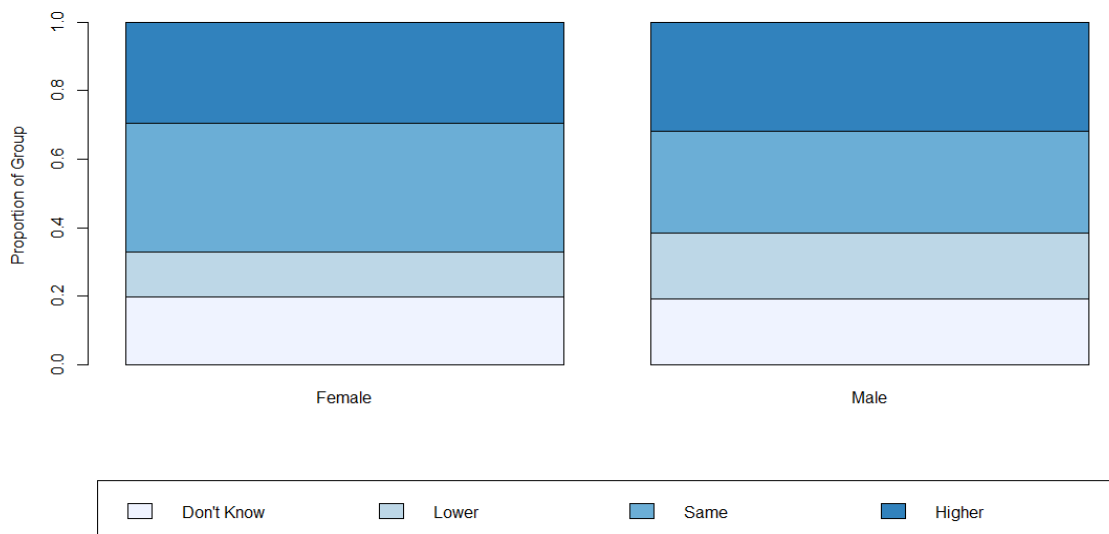


While there are clear differences in set point changes being made by participants in our study in different age groups, the differences are not statistically significant (Chi squared test returns  $p=0.15$ ). However, in our sample those in the 26 – 35 age group were more likely to increase the set point of their system than any other group.

### 3.2.2 Change in Set Point by Gender

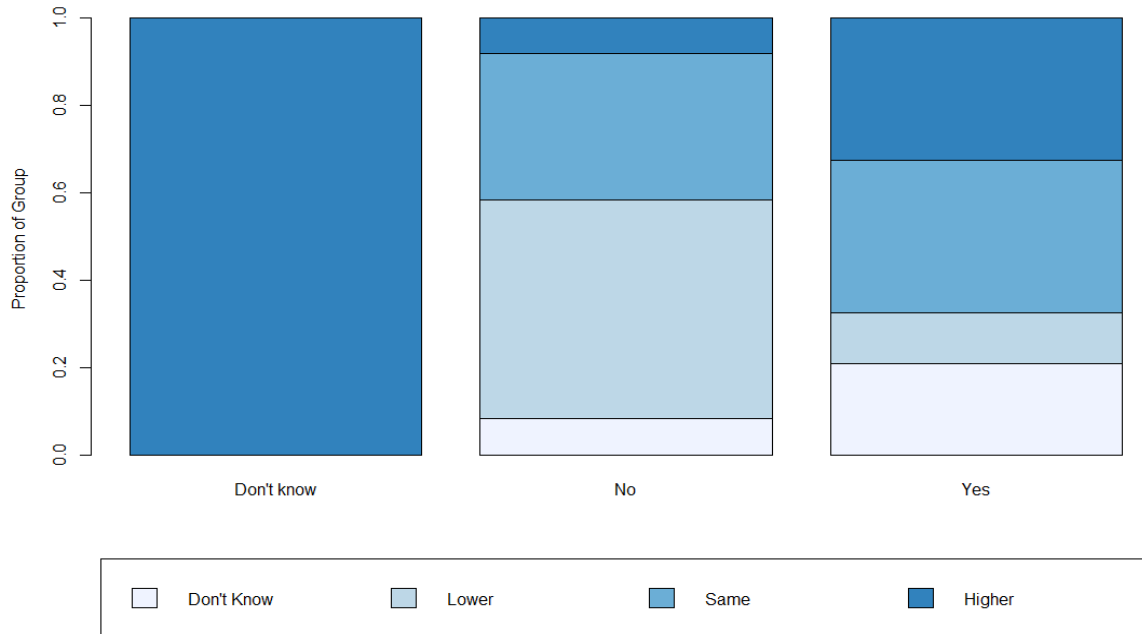
There is no noticeable difference between how men and women in our study exchanged their set point after having a heat pump installed.

Figure 14: Set Point Change by Gender



### 3.2.3 Change in Set Point by Presence of Someone Not in Employment, Education or Training

Figure 15: Set Point Change by Presence of Someone NEET



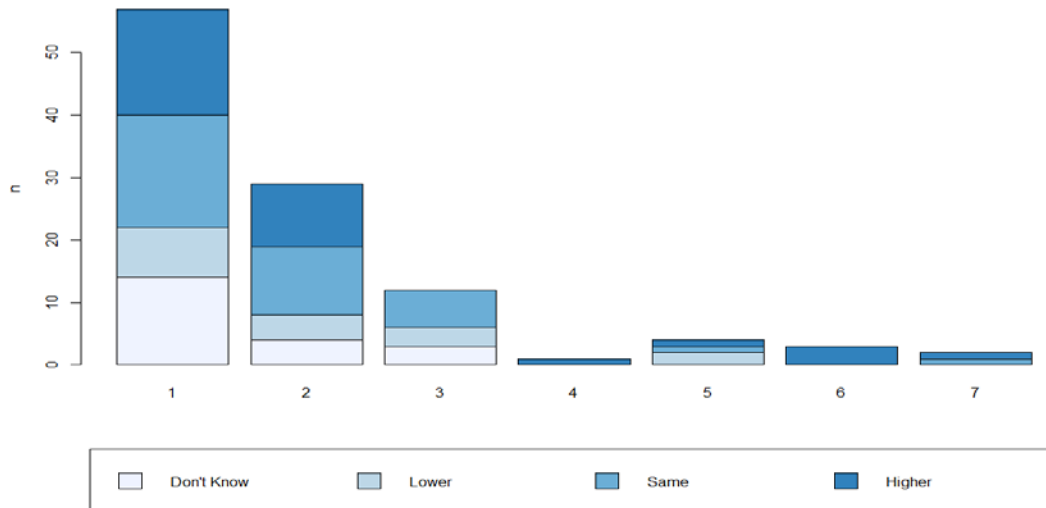
When comparing between households with and without someone not in employment, education or training, we can observe a significant difference in how the set point has changed after the installation of a heat pump (Chi-squared = 15.2368,  $p=0.018$ ). The principal difference that can be seen is that those without someone not in employment, education or training were more likely to use a lower set point, while households with someone not in employment, education or training were more likely to use a higher set point. There may be several explanations for this, including heat related health and wellbeing needs of those not economically active.



### 3.2.4 Change in Set Point by Occupancy

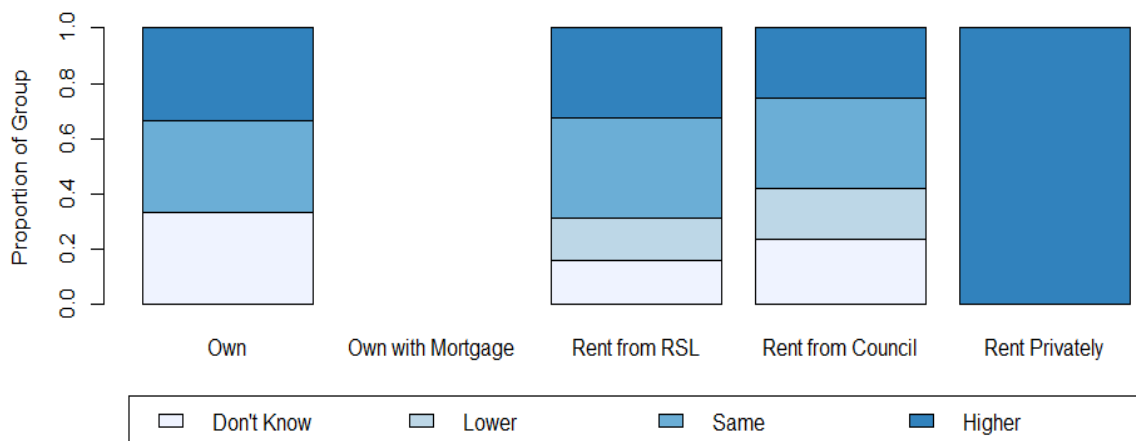
The sample composition means that it is difficult to compare between large and small households (as there are so few large households in the sample). However, using the available data it is not possible to detect a significant difference in set point changing behaviour between households of different sizes.

**Figure 16: Set Point Change by Number of Occupants**



### 3.2.4 Change in Set Point by Tenure

**Figure 17: Temperature Change by Tenure Group**

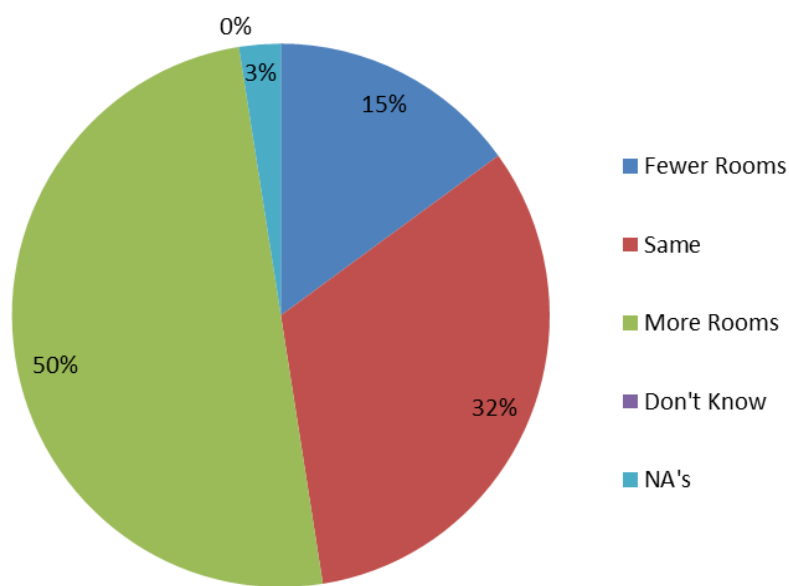


Each group has a similar mix of participants who increased, decreased and did not change their set point, and there are no significant differences between tenure. Even when focussing solely on renters, there is no significant difference between council land RSL tenants groups (Chi Squared test returns  $p = 0.69$ ).

### 3.3 Number of Rooms Heated

Number of rooms heated since installing the heat pump	n
Fewer Rooms	18
Same	39
More Rooms	60
Don't Know	0
NA's	3

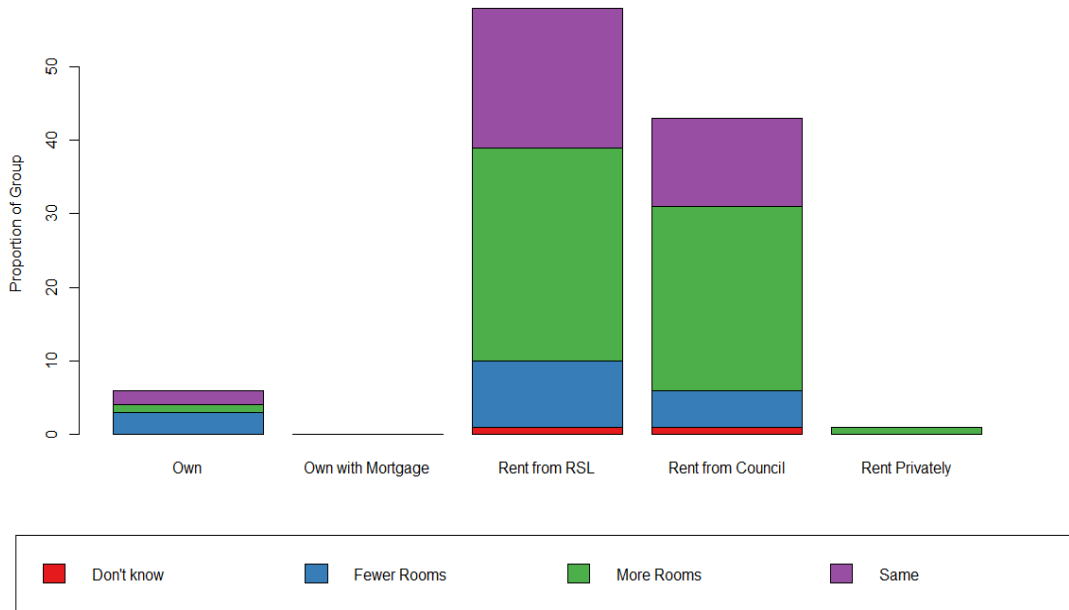
Figure 18: Increase or Decrease in Number of Rooms Heated



We can analyse the change in the number of rooms heated after the installation of a heat pump further by comparing differences between socio-demographic groups.

### 3.3.1 Rooms Heated and Tenure

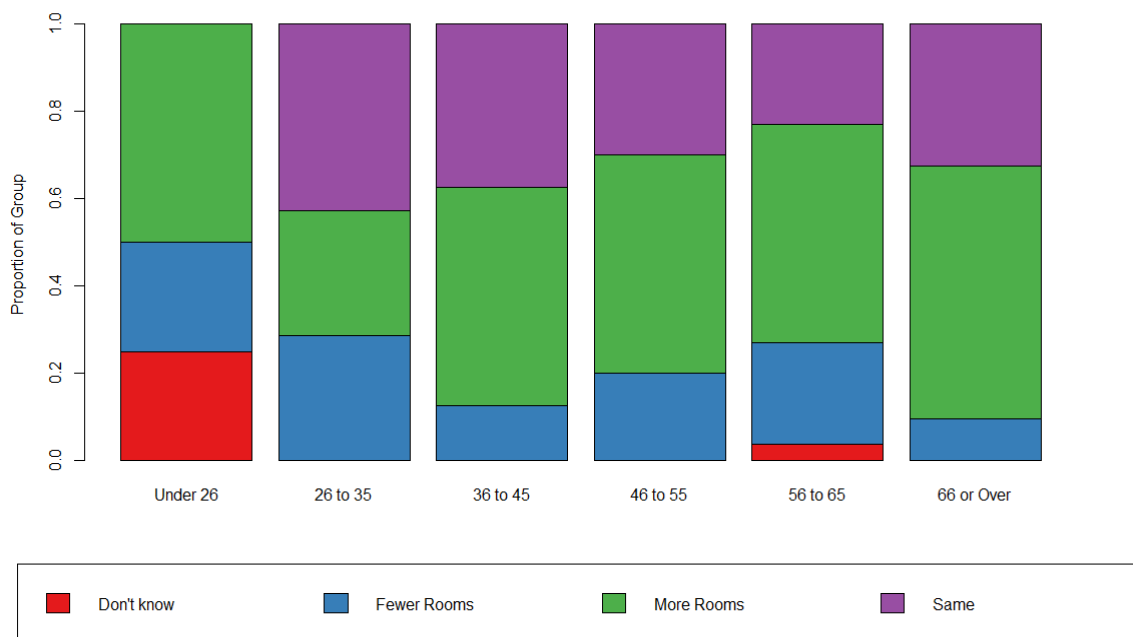
Figure 19: Rooms Heated by Tenure



There is no significant difference in the number of rooms heated after a heat pump installation between households of different housing tenure.

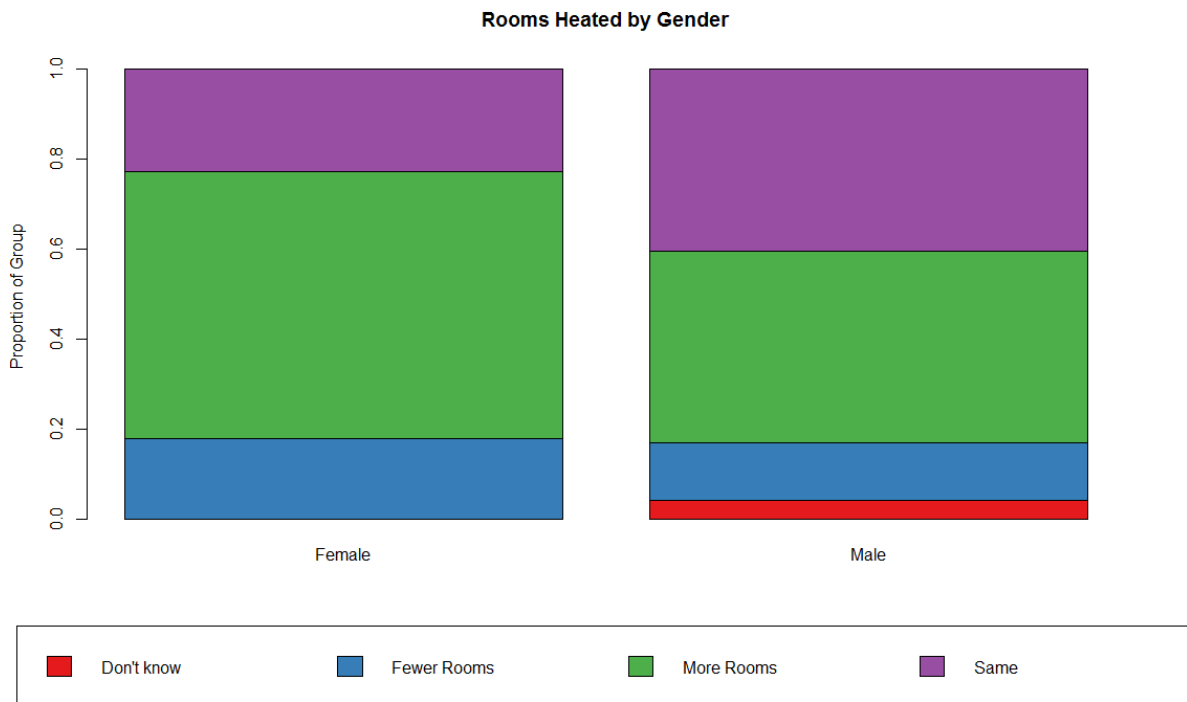
### 3.3.2 Rooms Heated and Age

Figure 20: Rooms Heated by Tenure



While there is no significant difference between age groups in terms of how many rooms they reported heating after a heat pump installation (Chi Sq test returns  $p=0.17$ ), we can see that none of the youngest group heated the same number of rooms, and this group was also most likely to not know whether more homes had been heated. Also, the group with the largest proportion of members to have heated more rooms was the over 65 Age Group (57%).

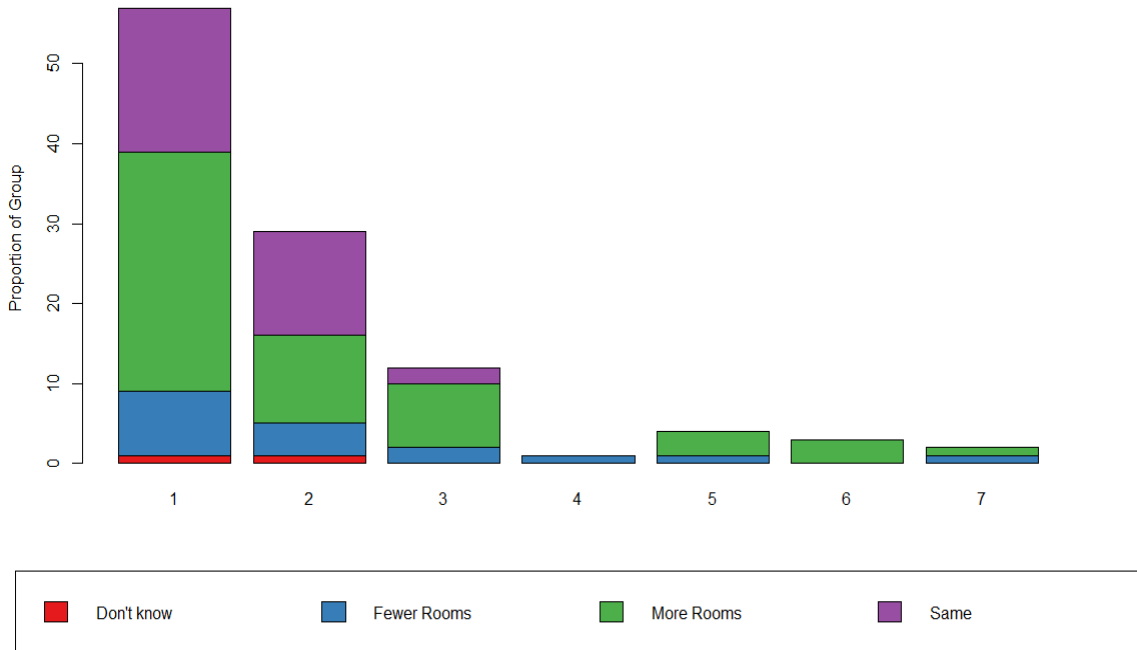
### 3.3.3 Rooms Heated and Gender



While the chart reveals that in our sample more female respondents heated more rooms than male respondents, Chi Squared testing confirms that the differences in the groups were not statistically significant ( $p=0.686$ ).

### 3.3.4 Rooms Heated and Occupancy

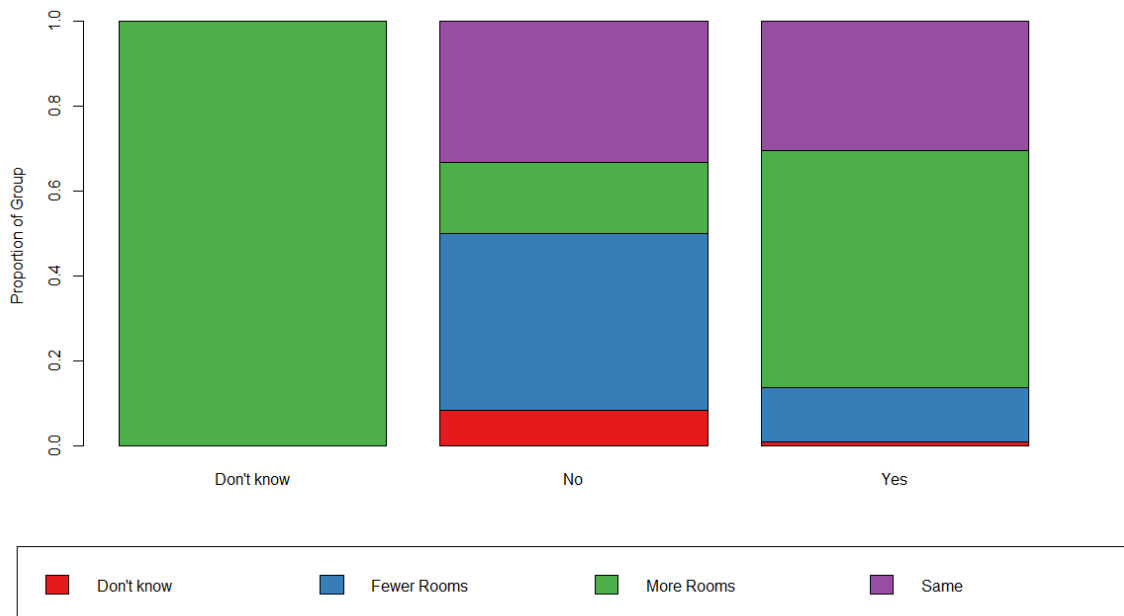
Figure 21: Rooms Heated by Occupants



There is no significant difference in the number of rooms reported to be heated after a heat pump installation and the number of people living in the home.

### 3.3.5 Rooms Heated and Presence of Someone Not in Employment, Education or Training

Figure 22: Rooms Heated by Presence of Someone NEET



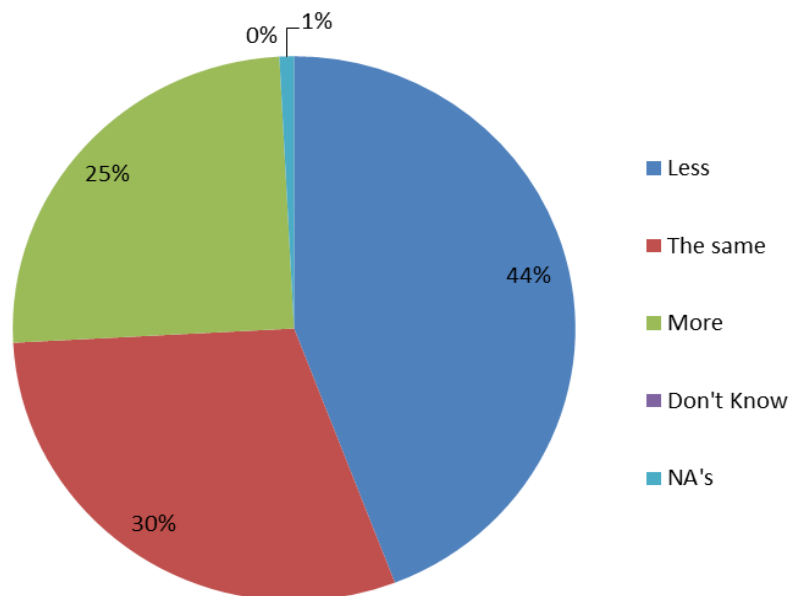
The above chart illustrates a clear difference between those with and without a member of the household who is not in employment, education or training. Importantly, those with someone not in employment, education or training are the group most likely to heat more rooms (ANOVA testing returns  $p=0.04$ ). Given that the social housing is a major part of the heat pump market place it is valuable to know that households with someone not economically active are likely to benefit from a heat pump by being able to heat more if not all of their home rather than be limited to heating one or two rooms.

### 3.4 Is the Heating On More or Less

Participants were also asked if the heating was on more or less since the installation of a heat pump. While it is not clear how participants might have interpreted this question, it is clear that most people felt that the heating was on less ( $n=53$ ) than before the installation.

Is the heating on more or less since the installation of the heat pump?	n
Less	53
The same	36
More	30
Don't Know	0
NA's	1

Figure 23: Heating Reported to be On More or Less



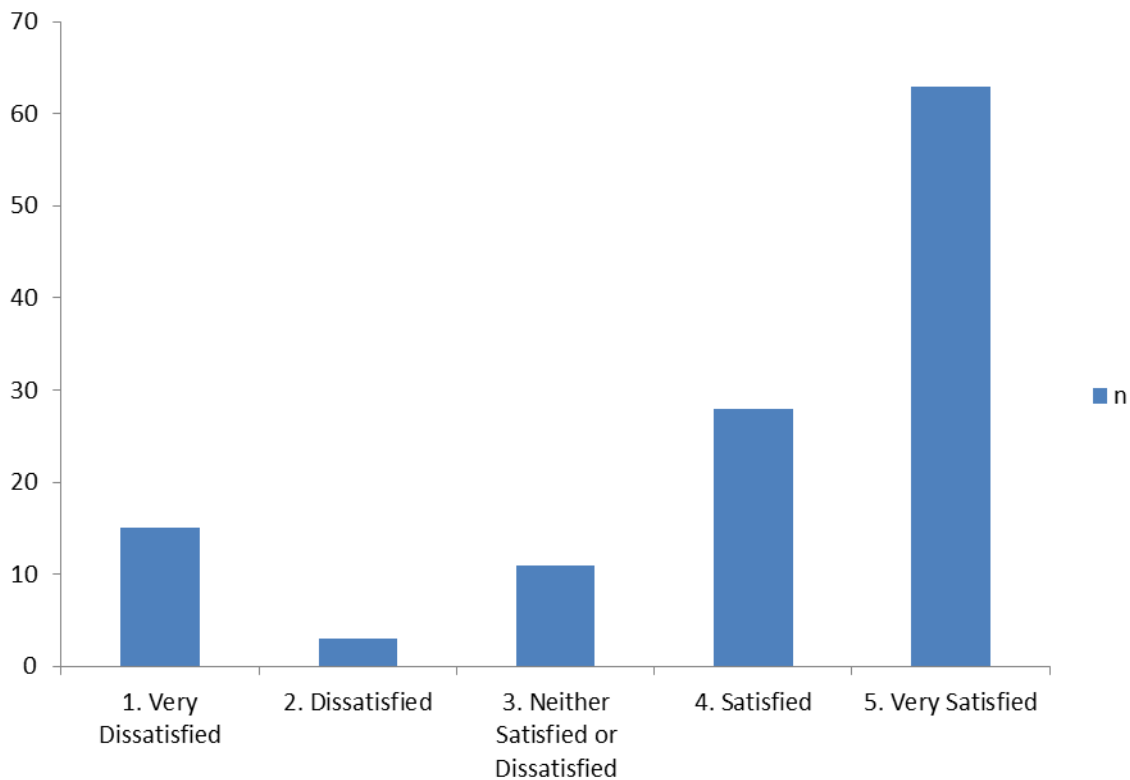
We do not conduct further sub-demographic analysis of these responses because of the uncertainty around how the question was interpreted by the participants.

## 4. User Sentiment

Respondents were asked rate their overall satisfaction with the new heat pump. The results show that the heat pumps were highly regarded in the main, with 76% of participants being either satisfied or very satisfied. However the results are not entirely positive, with 18 out 120 respondents (15%) of people dissatisfied or very dissatisfied.

Overall Satisfaction	n
1. Very Dissatisfied	15
2. Dissatisfied	3
3. Neither Satisfied or Dissatisfied	11
4. Satisfied	28
5. Very Satisfied	63

**Figure 24: Satisfaction with New System (1-5)**

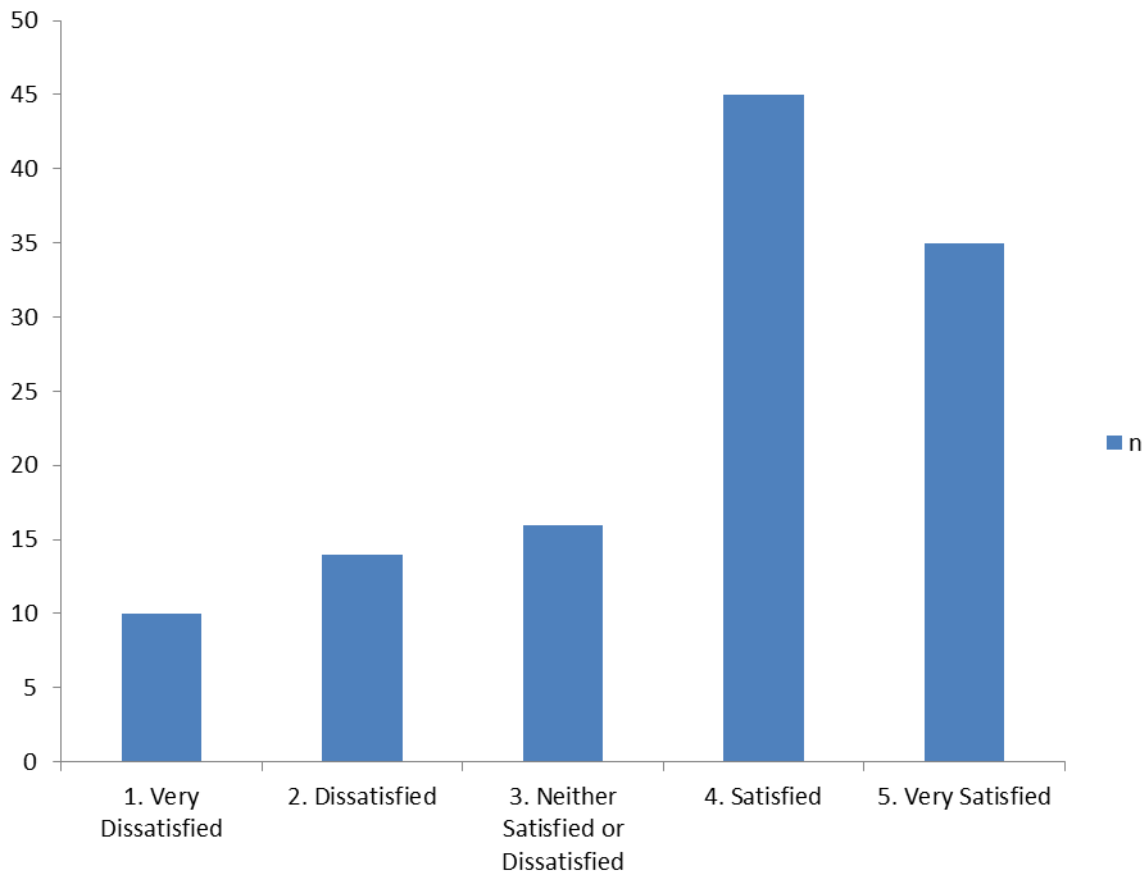


### 4.1 How Do You Rate the Appearance of the New System?

Respondents were asked to rate the appearance of the system. The responses were mostly positive, with 66% of people either satisfied or very satisfied. However, 20% felt either dissatisfied or very dissatisfied.

Appearance Rating	n
1. Very Dissatisfied	10
2. Dissatisfied	14
3. Neither Satisfied or Dissatisfied	16
4. Satisfied	45
5. Very Satisfied	35

Figure 25: Rating of the Appearance of the New System (1-5)



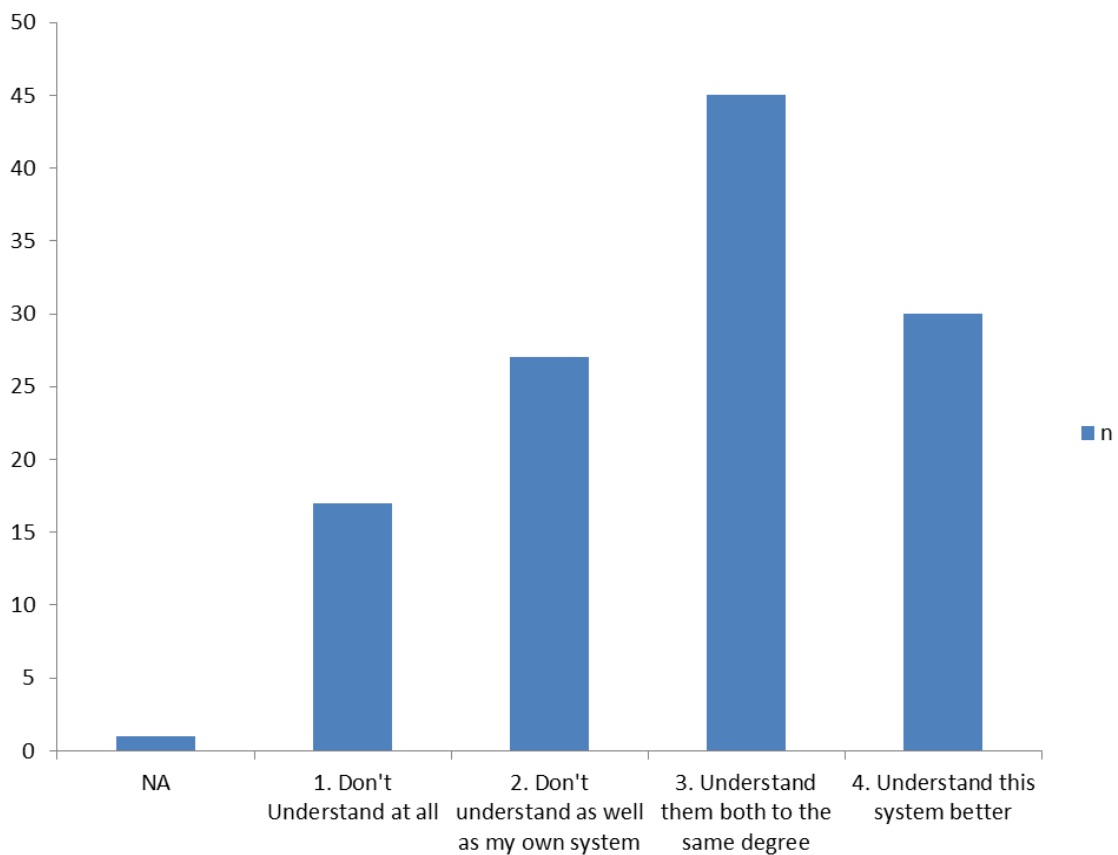


## 4.2 User Comprehension

Users were asked how well they understood the system compared to their previous system. The results show that the most common answer was that people understood the new system as well as they had understood their old one. However, 36% of people felt that they either did not understand it at all, or understand it less than their previous system. This suggests that the balance of sentiment around levels of understanding is more negative than positive, as only 25% of people felt that they understood this system better than their old one.

How well did users understand the new system	
NA	1
1. Don't Understand at all	17
2. Don't understand as well as my own system	27
3. Understand them both to the same degree	45
4. Understand this system better	30

**Figure 26: How Well is the New System Understood (1-5)**

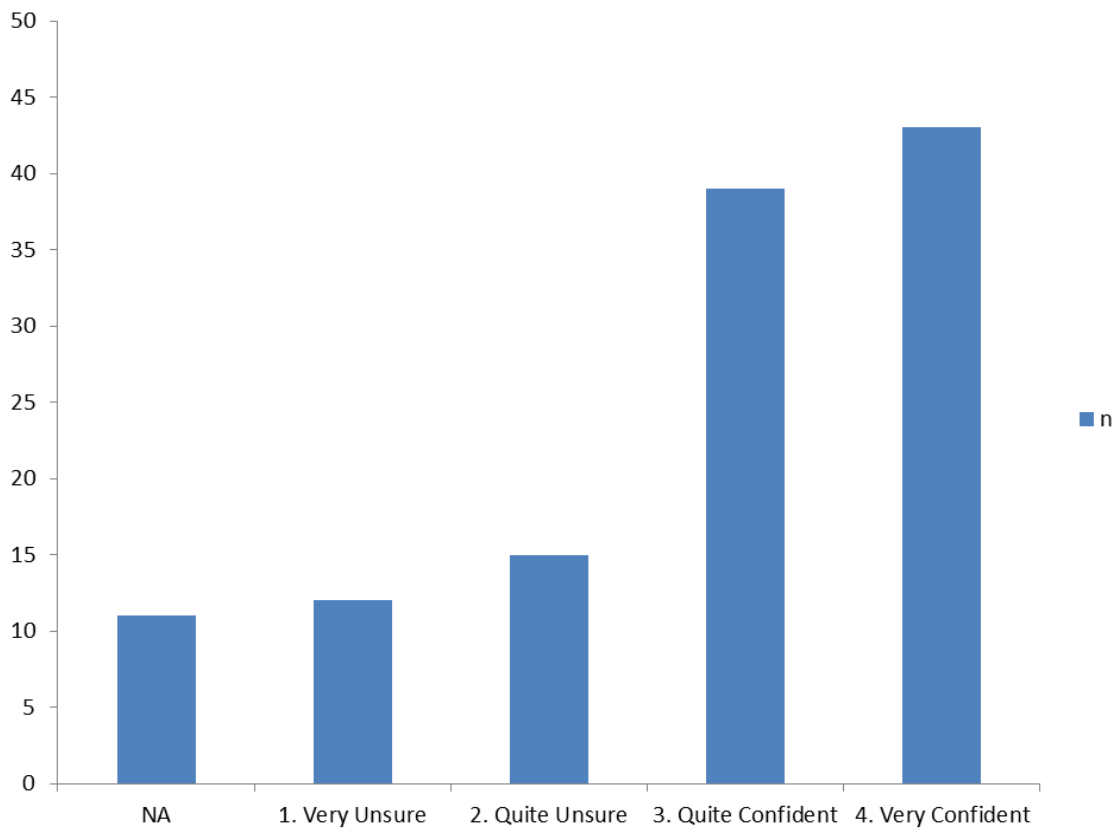


### 4.3 User Confidence

Respondents were asked to rate how confident they felt in using the control interface for the new heat pump. The results here show that the majority of people feel quite (32.5%) or very confident (36%) in using the new control panel.

Confidence when using the control panel	n
NA	11
1. Very Unsure	12
2. Quite Unsure	15
3. Quite Confident	39
4. Very Confident	43

**Figure 27: Rating of Confidence Using the Control Interface (1-5)**

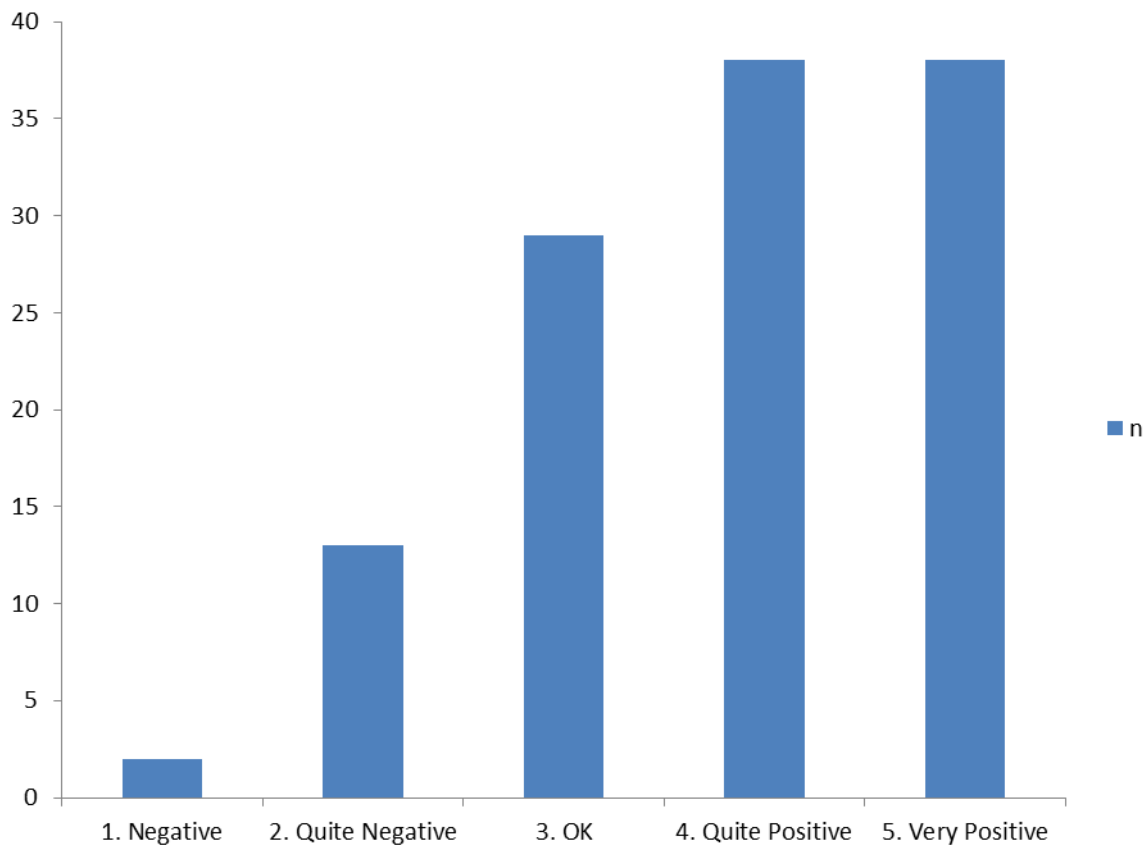


### 4.4 Change over Experience

People were asked to rate their experience of the change over from the old heating system to the heat pump system. The results are positive in the main, with only 12.5% of participants feeling negative or quite negative about the change-over experience. While this is a small percentage compared to the 87.5% of participants who felt either OK, positive or very positive it still represents 15 individual households who had a bad experience and if repeated across a wider scale roll-out this level of dissatisfaction would be a significant problem.

Change over experience rating	n
1. Negative	2
2. Quite Negative	13
3. OK	29
4. Quite Positive	38
5. Very Positive	38

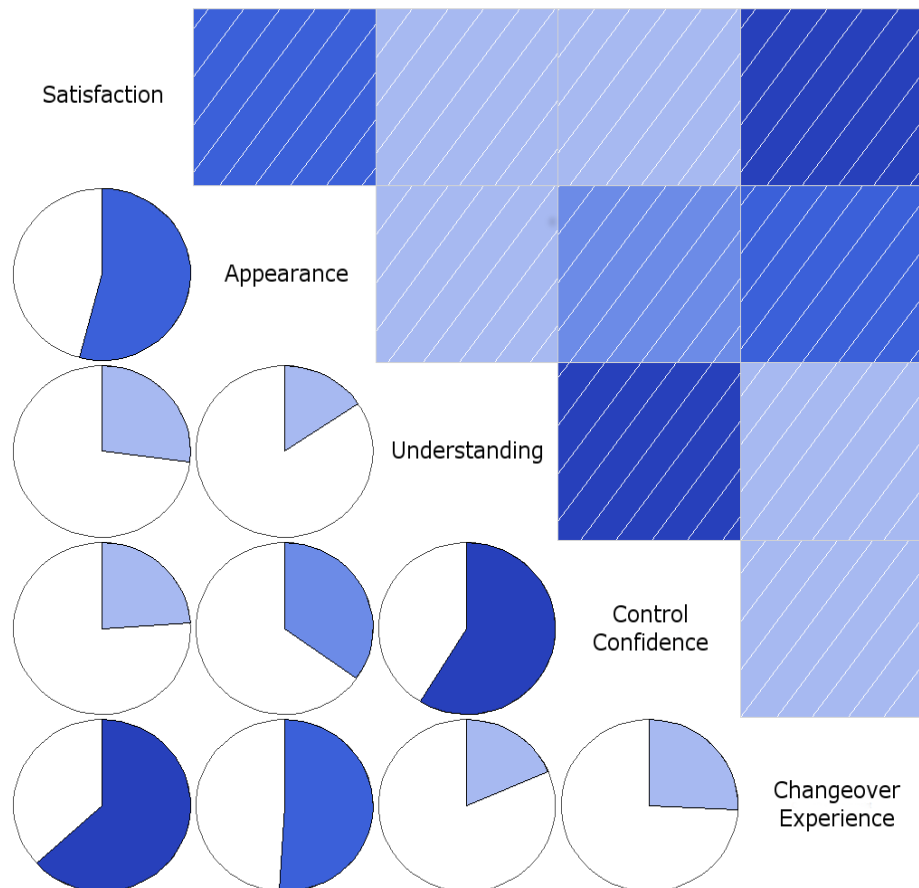
**Figure 28: Rating of the Changeover Experience (1-5)**



## 4.5 Testing for Associations between Sentiment Variables

At a high level it is possible to detect relationships between sentiment variables using a correlation matrix to generate a correlogram, as below. This reveals that the variables are correlated in several ways.

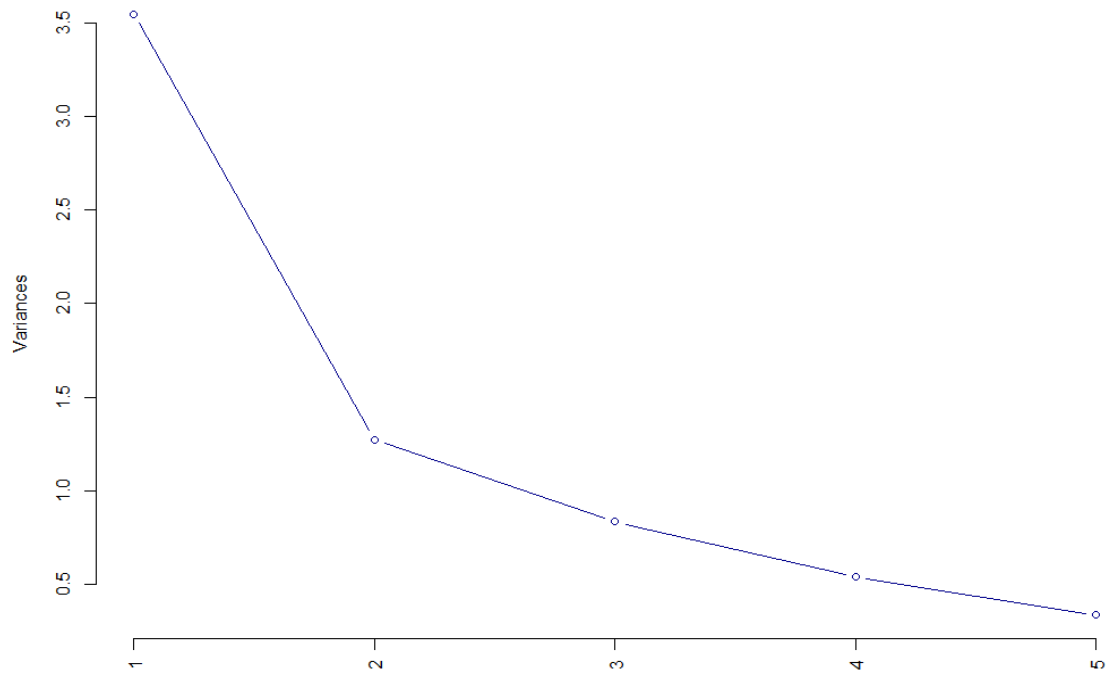
Figure 29: Correlogram



The blue colour indicates a positive correlation between all sentiment variables, the saturation of the colour indicating the strength of the relationship. In the bottom panel, the strength of relationship is also represented by the degree to which the circle is filled.

These associations between the data mean that there may be an underlying element that can be identified by principal component analysis. Conducting a PCA does indeed reveal a single principal component which accounts for 54.34% of the variance in answers to this group of questions. This PC will be referred to as Sentiment PC.

Figure 30: Identification of Principal Components in Subjective Survey Responses

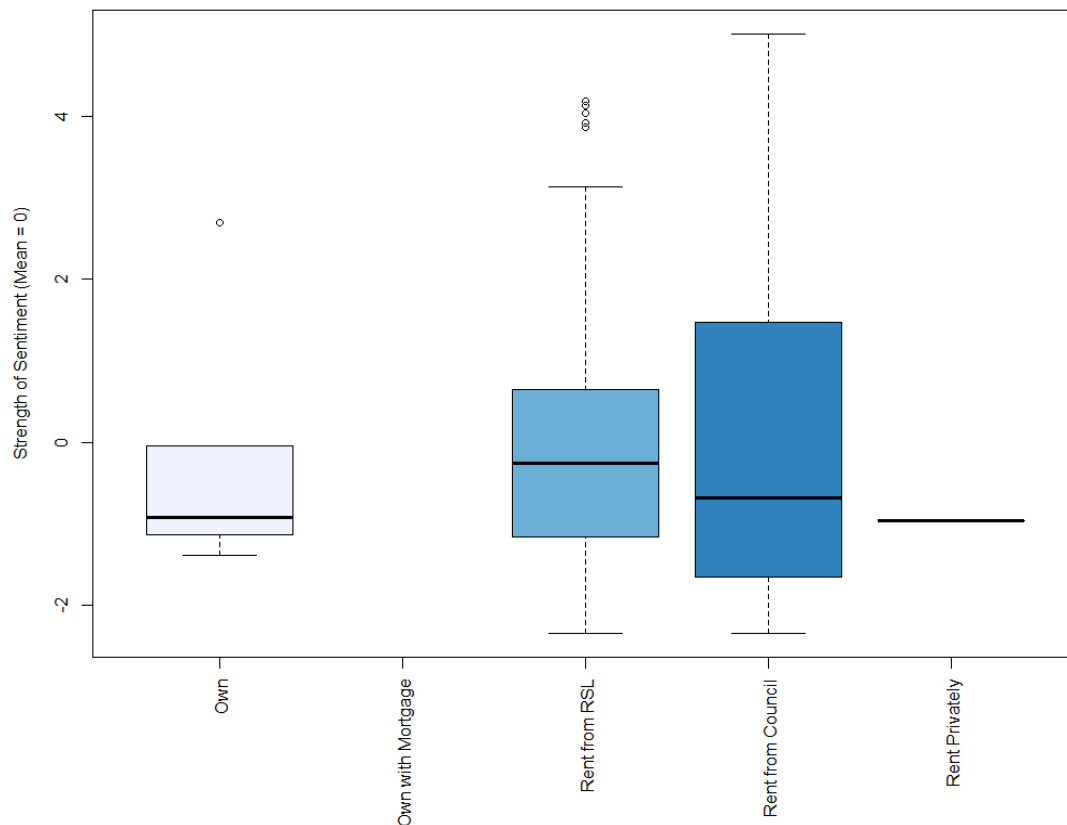


## 5. Testing for Associations between Sentiment and Socio-demographics

We now compare how Sentiment PC varies between groups to determine whether there are patterns in how groups of participants experienced and feel about their heat pump.

### 5.1 Sentiment and Tenure

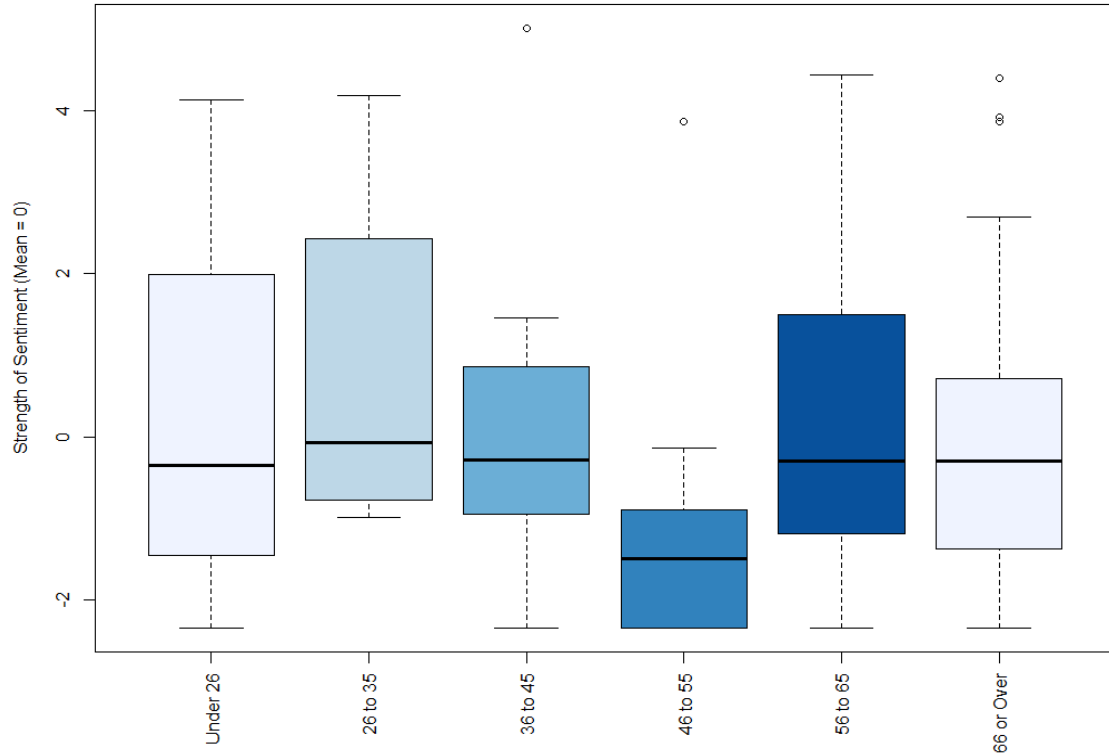
Figure 31: Sentiment by Tenure Group



Although there is no significant difference in the average Sentiment PC scores between participants in different housing tenure groups (ANOVA test returns  $p = 0.938$ ), it can be seen that the group with the widest range of scores is the group who rent their home from the council, where the range of sentiment scores is significantly wider than that for tenants of housing associations (RSLs). This group had some of the lowest sentiment scores and has a low average score relative to all groups other than private renters who have the lowest score.

## 5.2 Sentiment and Age Group

Figure 32: Sentiment by Age Group

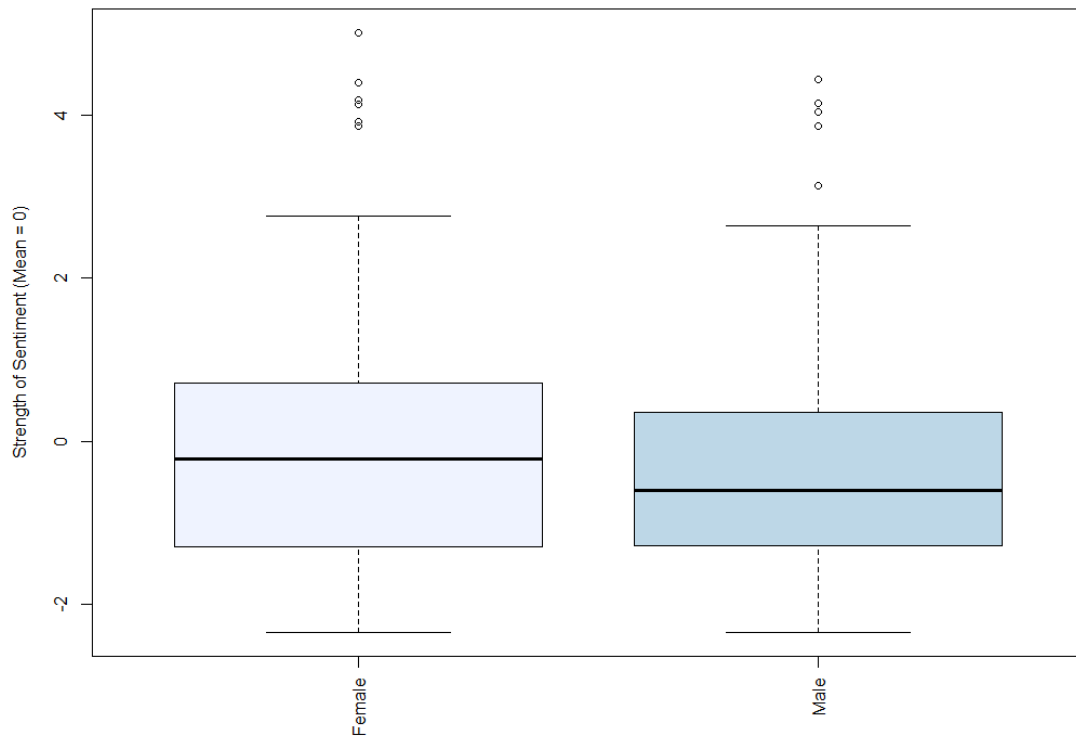


There is no significant difference in average Sentiment PC scores between age groups (ANOVA test returns  $p=0.421$ ) there was, in our sample, lower sentiment scores among participants aged 46 – 55 while all other age groups were relatively similar.

### 5.3 Sentiment and Gender

There was no noticeable difference in Sentiment PC scores between men and women.

Figure 33: Sentiment by Gender

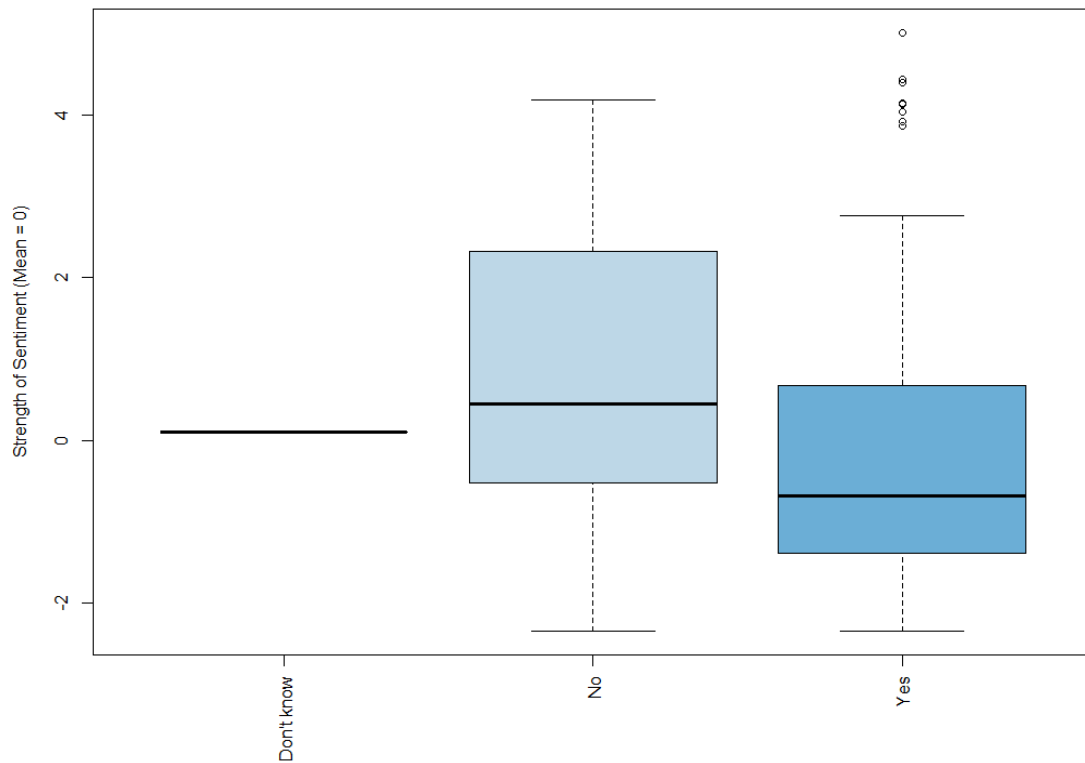




### 5.4 Sentiment and Presence of Someone Not in Employment, Education or Training

There was no statistically significant difference in Sentiment PC scores between households with and without someone not in employment, education or training (ANOVA test returns  $p = 0.252$ ). However, in our sample those with someone not in employment, education or training did display markedly lower average Sentiment PC scores.

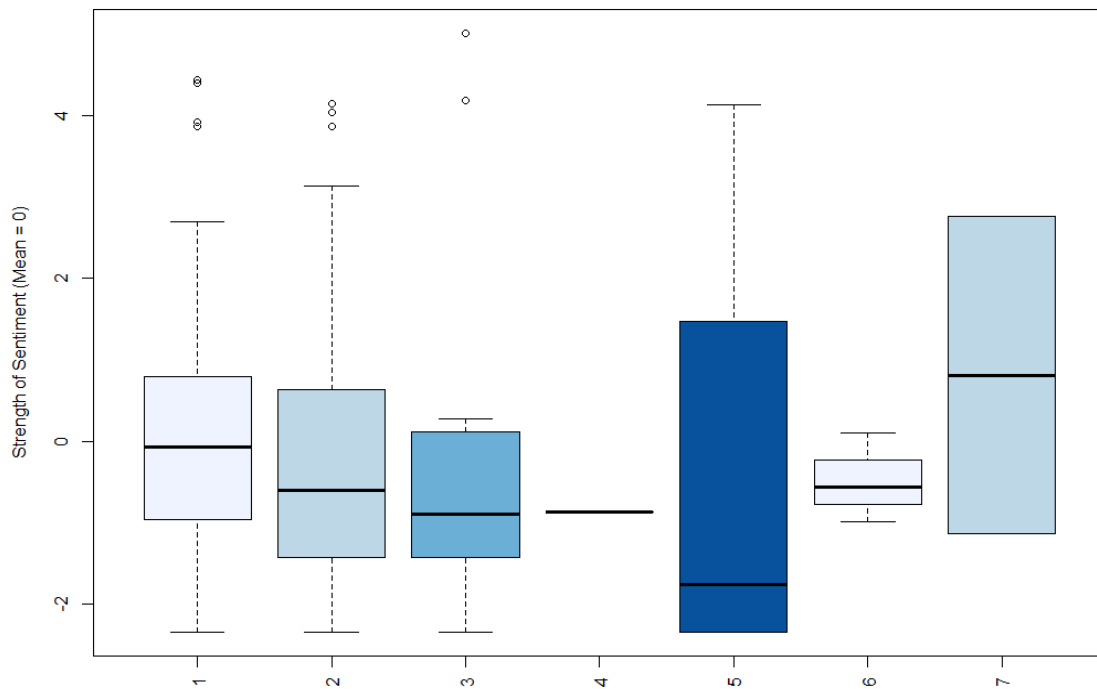
Figure 34: Sentiment by Presence or Absence of Someone NEET



### 5.5 Sentiment and Occupants

There is no statistically significant relationship between the average Sentiment PC scores of groups of respondents with different numbers of occupants in a property (ANOVA test returns  $p=0.981$ ). However, in our sample we can see that those with the highest sentiment PC scores are those with the fewest and the most occupants, with medium sized households having lower Sentiment PC scores – which represent overall underlying sentiment about the Heat Pump and the changeover process.

Figure 35: Sentiment by Occupancy

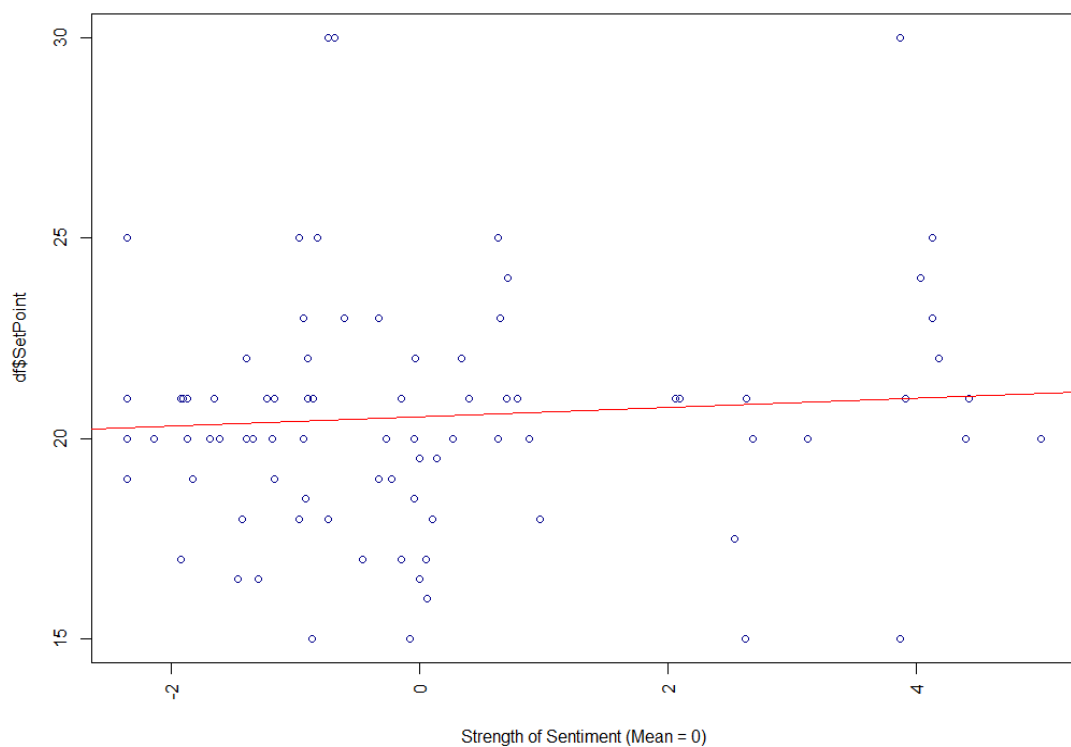


## 6. Relationships between Technical Variables and Sentiment PC

### 6.1 Sentiment and Set Point

The chart below plots Sentiment PC scores against reported system set point and reveals a positive, statistically significant relationship which indicates that those exhibit higher levels of satisfaction with the system as represented by Sentiment PC also have higher set points. As sentiment rises by 1 unit, set point rises by 0.1161 units. The causality is not clear, but there is a significant association to this linear relationship ( $p = <2e-16$ ).

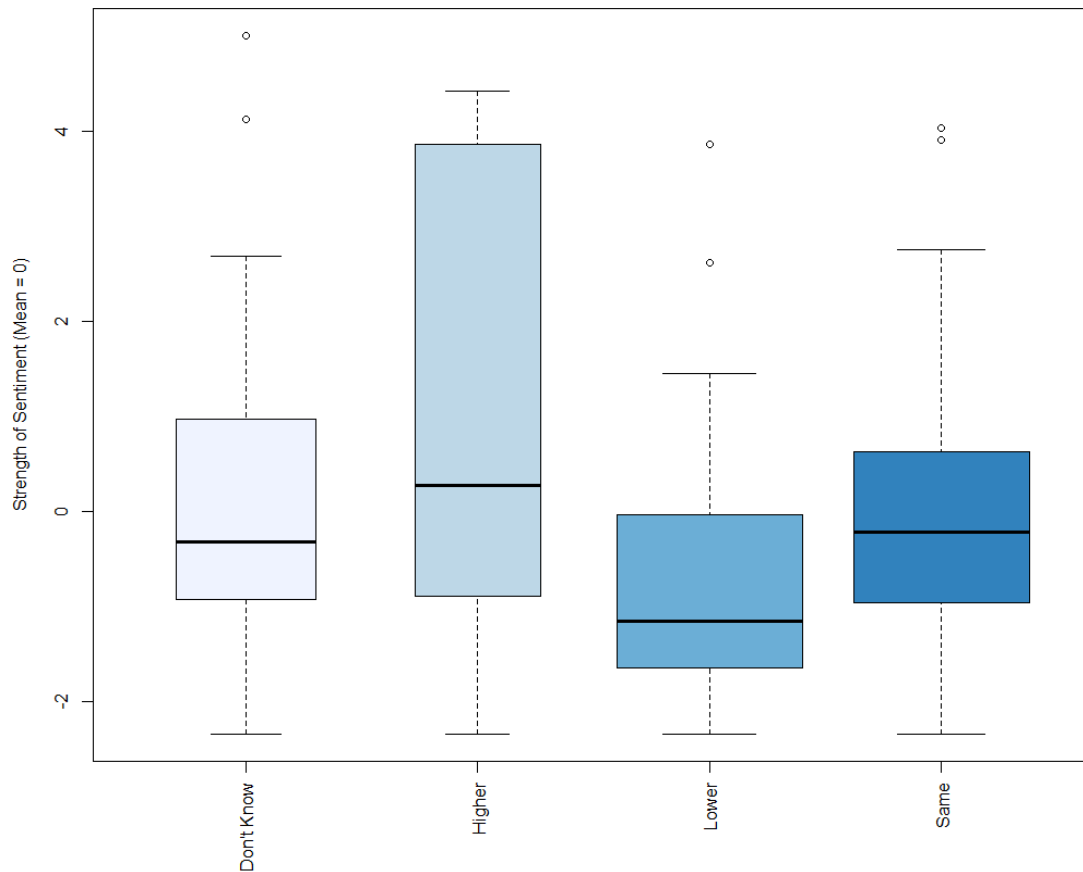
Figure 36: Sentiment and System Set Point



## 6.2 Sentiment and Change in Set Point

There is a statistically significant difference in Sentiment PC scores between groups of households who have changed their set point in different ways since having their heat pump installed.

Figure 37: PC1 (Sentiment) of Households Who Now Have a Higher, Lower or Unchanged Heating Set Point

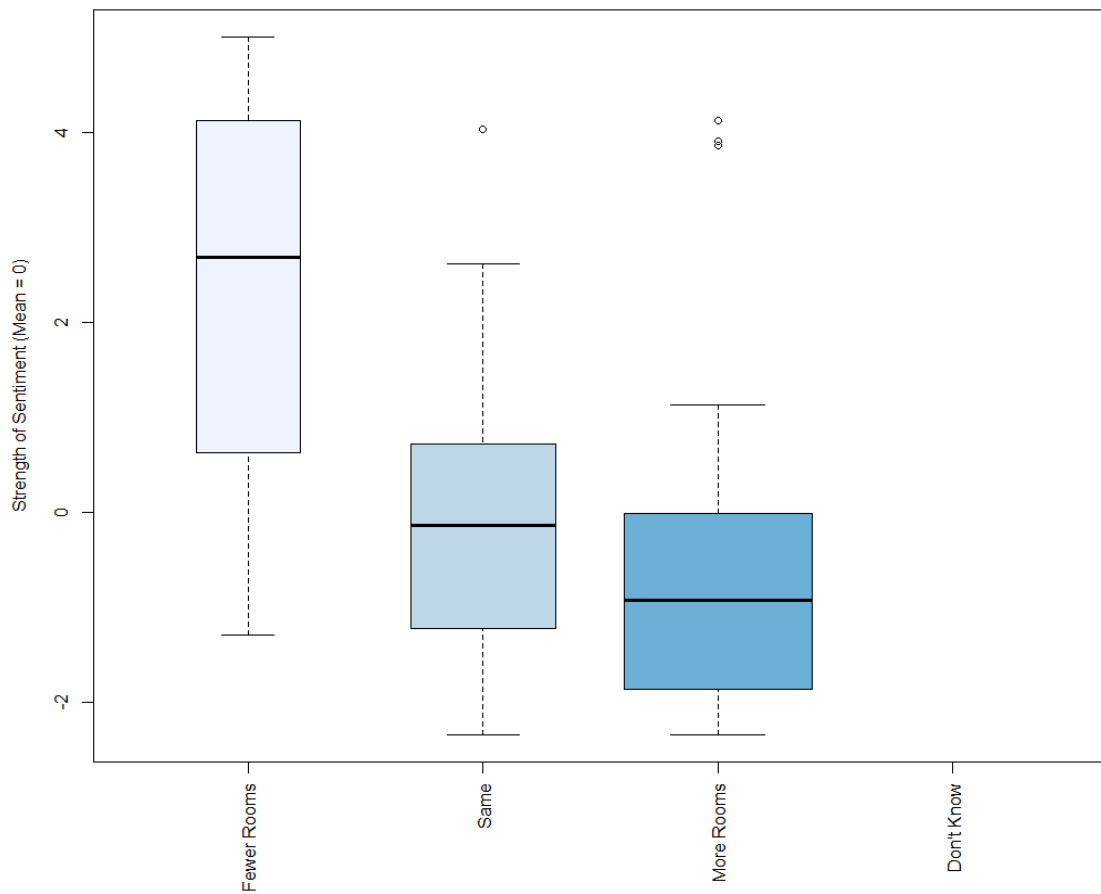


The boxplots show that those who have a higher set point have the highest levels of satisfaction while those who have lowered their set point have the lowest Sentiment PC scores. These differences are statistically significant (ANOVA test returns  $p=0.004$ ). It may be the case that those who have reduced their set point are doing so out of fear of increased bills and that this is leading them to have low levels of satisfaction.

### 6.3 Sentiment and the Number of Rooms Heated

We can see in the chart that participants now heating fewer rooms since the installation of a heat pump have, on average, the highest Sentiment PC scores while those heating more rooms now have the lowest levels of sentiment, as represented by Sentiment PC scores. This difference is statistically significant, (ANOVA test returns  $p < 5.5e-09$ ).

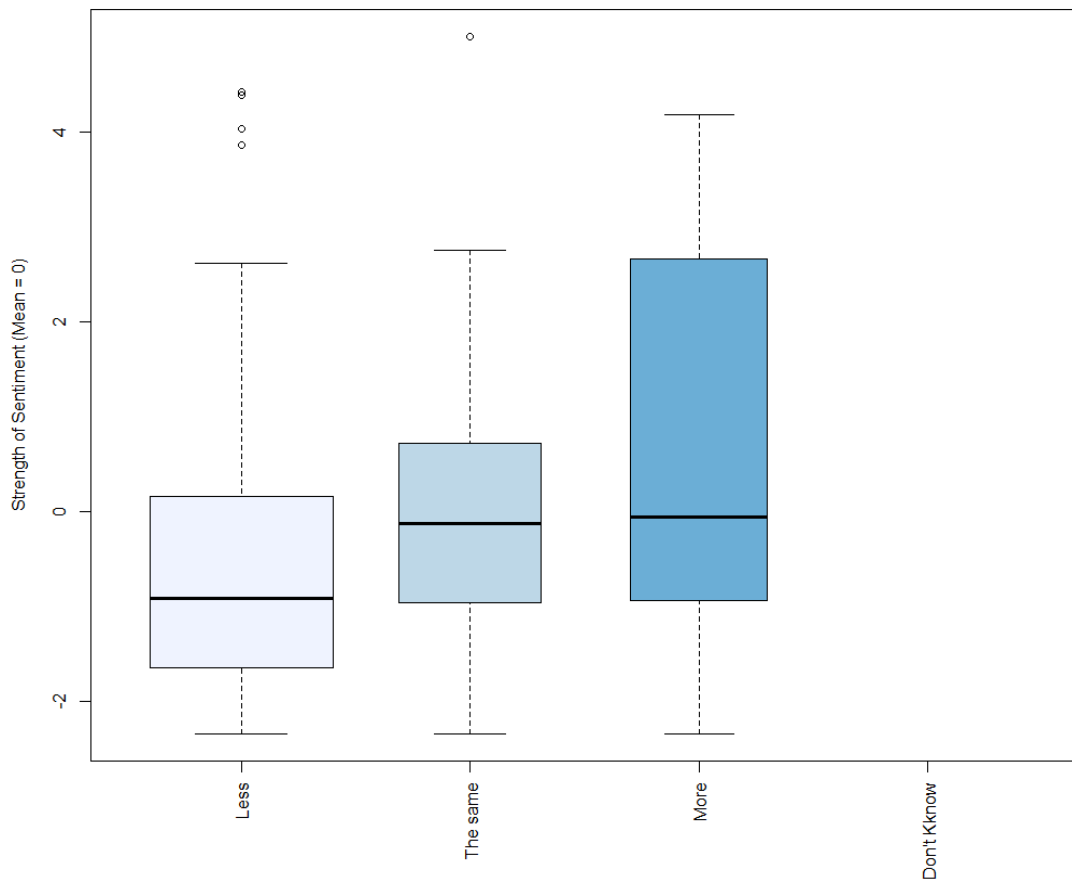
**Figure 38: PC1 (Sentiment) of Households Using Heat Pumps Less, the Same or More Than Their Previous System**



### 6.4 Sentiment and Heating Usage

There is no statistically significant difference in average sentiment as represented by Sentiment PC between households how use their heating more, the same or less (ANOVA test returns  $p=0.052$ ). However, in our sample, those who had their heating on more than previously had higher average Sentiment PC scores than those who were reusing it the same or less than previously.

Figure 39: PC1 (Sentiment) of Households Using Heat Pumps Less, the Same or More Than Their Previous System



## 7. Conclusion

This report has investigated the impact of the heat pumps system in households, user sentiments, associations between sentiment and socio-demographics, and relationships between technical variables and sentiment PC.

The majority of 120 survey participants reside in properties rented from RSL (51%) or Council (42%) (Figure 1), and half of the respondents are aged 66 or over (Figure 2) with 55% of female respondents (Figure 4). Figure 5 shows that half of respondents live in single person household (53%) and 27% of respondents two occupants in the house.

The most common set point at which their heat pump system is working to is 20 and 21 degrees (Figure 7). The results show that the temperature at which they set their heating systems stayed the same but more than twice as many people reported a lower set point than a higher one (Figure 12). Another important finding is that that most people felt that the heating was on less (44%) than before the installation (Figure 23).

The results show that the heat pumps were highly regarded with 76% of participants being either satisfied or very satisfied with the technology (Figure 24). The majority of people feel quite or very confident in using the new control panel (Figure 27). There is a statistically significant difference in Sentiment PC scores between groups of households who have changed their set point in different ways since having their heat pump installed (Figure 37).



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