Heating controls for the visually impaired

Northumberland County Blind Association (NCBA)

August 2019

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Process

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1 Executive summary

Northumberland County Blind Association (NCBA) successfully bided into an Energy Saving Trusts (EST) competition for Ofgem's Energy Industry Voluntary Redress Scheme. The "heating control scheme for those with a visual impairment" project was designed to pilot four different kinds of technology solutions into households that have a person who has a visual impairment disorder.

NCBA subcontracted all delivery other than trialist recruitment to Narec Distributed Energy (NDE).

NDE delivered the majority of the project in-house with directly employed staff, although did use 18th Edition qualified electricians from North East Electrical Ltd, Gas Safe registered engineers from 0800 Repair Ltd, and a visual processing specialist from Jordan Eyes in order to complete the project.

Delivery of the project began in November 2018 and ended in August 2019, though with recruitment delays installations did not begin until March 2019.

During the installation process, some trialists refused coloured dial stickers and task lighting interventions which meant more installations of Alexa voice control with Honeywell Lyric were deployed. A total of 26 homes were planned for installation, however only 17 homes had installations that remained in place throughout the trial period.

In broad terms, across all interventions trialists appeared to be more engaged with their heating with both the mean and median of living room temperature lower after the intervention was installed - demonstrating better control of heating.

A larger field trial that starts earlier in the heating season from September rather than March could help establish a more robust understanding of how Alexa voice control with Honeywell Lyric (intervention C) benefits those with a visual impairment. A greater sample size would also allow for a more statistically significant analysis of temperature logging data to be carried out, which would help to quantify the degree to which those with visual impairment can better control and manage the heating in their home.

2 Introduction

2.1 Background

Northumberland County Blind Association (NCBA) successfully bided into an Energy Saving Trusts (EST) competition for Ofgem's Energy Industry Voluntary Redress Scheme. The "heating control scheme for those with a visual impairment" project was designed to pilot four different kinds of technology solutions into households that have a person who has a visual impairment disorder.

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NDE delivered the majority of the project in-house with directly employed staff, although did use 18th Edition qualified electricians from North East Electrical Ltd, Gas Safe registered engineers from 0800 Repair Ltd, and a visual processing specialist from Jordan Eyes in order to complete the project.

Delivery of the project began in November 2018 and ended in August 2019 with the issuing of this document. Milestones and related timelines are outlined below within Table 1.

Table 1 – Timeline of project stages and milestones

Stage	Milestone	Oct-18	Nov-18	Dec-18	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19
Award	Grant award	■										
	Contract signed		■									
Engagement	Recruitment		■	■	■							
	Pre-install visit		■	■	■							
	Visual Processing Assessment				■							
Deployment	Review & plan					■						
	Installations						■					
	Follow-up checks						■	■				
	Post-install visit										■	
	De-installation (if required)										■	
Analysis	Analysis & report											■

3 Methodology

The approach taken to deliver the project is outlined below within the sub-sections Engagement, Deployment and **Error! Reference source not found.**.

3.1 Engagement

3.1.1 Recruitment

NCBA recruited participants for the trial through their membership and that of other organisations involved with supporting those with visual impairment. This recruitment did fall behind schedule due to NCBA internal capacity issues. This led to delays in the project start, in order to mitigate these delays, engagement activity by NDE began before recruitment had finished.

3.1.2 Pre-install visit

In total, NCBA recruited 30 homes across Northumberland, although after pre-install visits conducted by NDE to complete pre-install questionnaires and obtain signed consent form this dropped to 26 homes. While meeting with trialists at pre-install visits, temperature datalogging equipment was deployed to the living room, hall and master bedroom of each home.

3.1.3 Visual Processing Assessment

Ian Jordan of Jordan Eyes then carried out a visual processing assessment of the 26 homes to help inform the allocation of interventions to trialist homes.

3.1 Deployment

3.1.1 Review & plan

Information about visual impairment provided by NCBA and the results of visual processing assessment was reviewed and intervention types allocated, creating a schedule for the installation teams.

3.1.2 Installations

This section sets out the equipment used for each of the four interventions A-D, as well as the temperature logging equipment. Latterly a breakdown of the 26 homes is provided.

3.1.2.1 Equipment

3.1.2.1.1 Intervention A

Coloured dials stickers onto any existing room thermostat (Figure 1) to indicate the direction of hot and cold to improve visibility.

Figure 1 – Intervention A

3.1.2.1.2 Intervention B

Task lighting (Figure 2) to improve the light levels onto the room temperature controls to improve the visibility of them.

Figure 2 – Intervention B

3.1.2.1.3 Intervention C

A "smart" thermostat (Figure 3). Replacing the existing thermostat and boiler controller with a Honeywell Lyric connected to an Alexa Echo Dot, the user can use voice control to turn the heating system on or off.

Figure 3 – Intervention C

3.1.2.1.4 Intervention D

A large display thermostat (Figure 4). Replacing the existing thermostat and boiler controller with a Honeywell Evohome, the user is able to change set point temperature and schedules (if required).

Figure 4 – Intervention D

3.1.2.1.5 Temperature dataloggers

Dataloggers (Figure 5) were deployed in the living room, hall and master bedroom of all homes that had interventions A-D deployed. These loggers were deployed during the pre-install visits on internal walls or surfaces away from heat sources and direct sunlight.

Figure 5 – Tiny Tag 2 temperature datalogger

3.1.2.2 Installed (17 homes)

During the installation process, some trialists refused interventions A & B which meant more installations of intervention C were deployed. However, although 26 homes were planned for installation only 17 homes had installations that remained in place through until the post-install questionnaire at the end of the trial (Table 2).

Table 2 – Homes with interventions 5installed for the duration of trial

Intervention	Homes
A	6
B	3
C	6
D	2
A-D	17

3.1.2.3 Refused (4 homes)

Homes 2 and 6 had no internet meaning intervention C was not feasible, other interventions were refused. While homes 11 and 25 declined either interventions A or B.

3.1.2.4 Unreachable (2 homes)

Home 27 was booked and the appointment confirmed by telephone and letter a week before the day of installation. However, upon arrival, on the morning of install, neighbours informed the team the trialist had moved. This was backed up by the telephone number being out of service.

Home 30 had been booked in, but needed to be cancelled as the installation team were running behind on earlier jobs. The project manager spoke with the trialist who was fine with this, but two days later when calling back to rearrange an install there was no answer. For a week each day and night there was no answer. The project manager visited the property to see if there was a problem with the landline, no answer at the door either.

3.1.2.5 Other (3 homes)

At home 7 there were problems with the boiler switching on/off after installing intervention C. An electrician and Gas Safe registered engineer worked to repair the boiler the same day. Ultimately after multiple parts of the boiler were replaced over several days and following feedback on Thursday 21st March 2019 from the trialist that the boiler was working normally it was decided to remove the home from the trial. Over £500 in labour and parts has been spent to repair the boiler, the Alexa Echo Dot was gifted, but the Honeywell Lyric was removed and the original controls re-installed. Temperature dataloggers were also removed.

Home 15 had been in the process of getting a new boiler for several months, a cut-off date was agreed, and after Thursday 21st March the home was removed from the trial. As such it has not been possible to install an intervention. Note that the installation team had previously been booked in and turned up at the property and were unable to carry out the deployment.

Home 24 despite agreeing to take part in the project the trialist had a Hive with voice control installed two weeks before.

3.1.3 Follow-up checks

Between 1 to 2 weeks following installation trialists were contacted by the project manager to identify any problems or issues. It was only necessary at home 3 for the project manager to go out to see the trialist to ensure they fully understood how to operate their heating.

3.1.4 Post-install visit

Follow-on post-installation questionnaires were completed and temperature dataloggers were recovered.

3.1.5 De-installation (if required)

During the post-installation survey some 6 months+ after the installation, trialists were asked if given the opportunity would like to keep the technology permanently. As a result, a number of interventions were removed, de-installation rates were:

- Intervention A - 50% of homes (3 of 6)
- Intervention B - 66% of homes (2 of 3)
- Intervention C - 17% of homes (1 of 6)
- Intervention D - 0% homes (0 of 2)

4 Analysis

4.1 Questionnaires

A total of 30 participants were recruited by NCBA, though this dropped to 17 homes where measures were installed and both pre and post-install questionnaires completed.

Installations were carried out to a greater or less extent in a further 9 homes, taking the total number of homes where interventions were installed or at least attempted on the day of installation to 26 homes.

In respect to the 17 homes with interventions and questionnaire responses; 13 were owner-occupier, 2 private rented and 2 social housing.

Building fabric was generally good, with 3 homes having un-insulated walls; 2 had cavity walls and 1 was solid wall.

A single property was on LPG opposed to mains gas, but also used solid fuel stove for heat, with all 17 homes having gas boilers. Two homes stated using electric heating as their main source of heat, despite having main gas boilers.

In terms of connectively; 15 homes had the internet, with 7 homes already having an Alexa or equivalent.

Within the 17 homes 12 (71%) homes had trialists who were over 60, with the remaining 6 homes (29%) homes having trialist aged between 16 to 59.

Household income varied across the 9 of 17 who responded to this question, responses can be seen below within Figure 6.

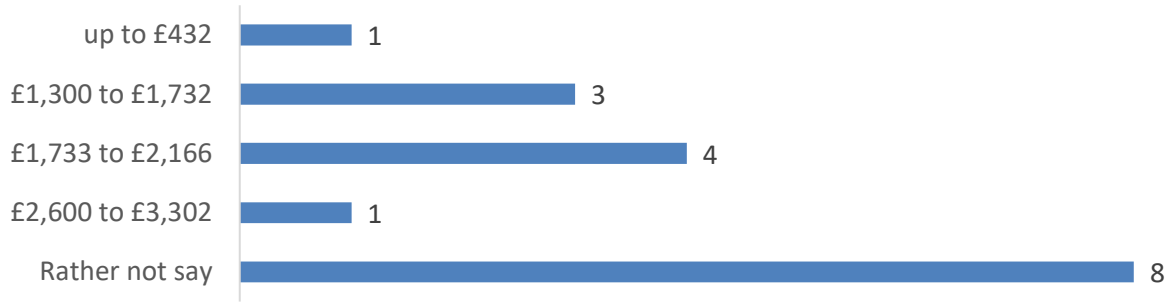

Figure 6 – Monthly household income

Interestingly for those who reported condensation, damp, mould or draughts, these issues or even their severity was not linked to household income. There was also no significant change between pre and post-install survey responses.

This is illustration below with Table 3 for damp and Table 4 for mould at pre-install survey stage.

Table 3 – Damp problems within homes across household income categories

	Homes
not at all	**13**
up to £432	1
£1,300 to £1,732	3
£1,733 to £2,166	2
£2,600 to £3,302	1
Rather not say	6
slight problems	**4**
£1,733 to £2,166	2
Rather not say	2
	17

Table 4 – Mould problems within homes across household income categories

	Homes
not at all	**14**
up to £432	1
£1,300 to £1,732	3
£1,733 to £2,166	2
Rather not say	8
slight problems	**3**
£1,733 to £2,166	2
£2,600 to £3,302	1
	17

At both pre and post-install trialists were asked to rate their satisfaction of indoor temperature, humidity and air freshness, on a scale (not at all [0], slightly [1], somewhat [2], very [3], extremely [4]). Analysis of the responses showed positive and negative changes against each measure; results were inconclusive, with the median difference for each measure being zero.

There was also no change in the ability of trialists to keep their homes warm during cold weather; all were able to do so before and after the installation of their intervention.

When asked to rate how difficult it was to meet fuel bills, 13 homes (76%) reported finding it either very easy, fairly easy or neither; while 4 homes (24%) found it fairly difficult, with no homes reporting to find it very difficult.

Only 1 (6%) trialist reported changing energy supplier within the last 12 months, with 7 (41%) having never changed, 4 (24%) had done so within the last 4 years and 5 (29%) switched supplier within last 1-3 years.

Trialists were asked rate their own health, 12 (71%) reported to be in fair to good health, while 5 (29%) indicated to be in bad or very bad overall health.

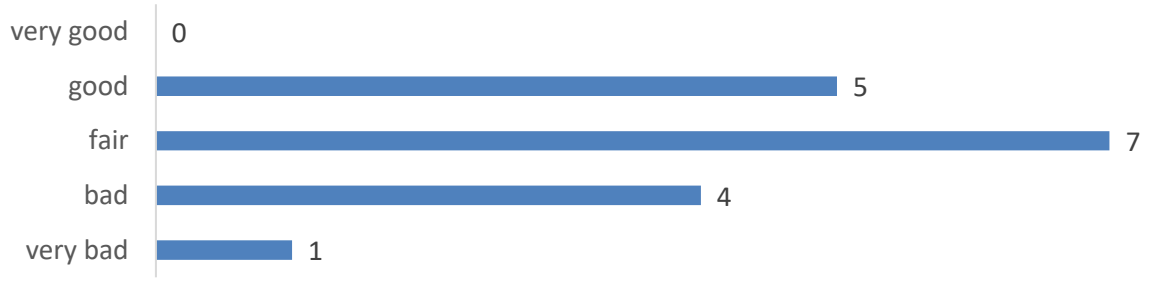

Figure 7 – Trialist self-assessment of own overall health

A series of questions at pre and post-installation were design to assess health and wellbeing, these were:

- Overall, how satisfied are you with your life nowadays?
- Overall, to what extent do you feel the things you do in your life are worthwhile?
- Overall, how happy did you feel yesterday?
- Overall, how anxious did you feel yesterday?

Trialists were asked to respond on a scale, not at all [0] to completely [10]. Only 15 of the 17 homes completed these questions in full at pre and post-install survey.

Results were mixed, with median across trialists for each question being zero (no change), other than "how happy did you feel yesterday" on a scale of 0-10, which fell by 1.

Detailed feedback was obtained from 15 of the 17 homes, specifically questions were:

- What could have been done better, when giving you assistance in using the new controls?
- What problems have you experienced using the new controls?
- Can you think of any improvements that would make the technology better or easier to use?

These findings are discussed below within sections 4.1.1.1, 4.1.1.2, 4.1.1.3 and 4.1.1.4 below.

4.1.1.1 Intervention A

Fully deployed in 6 homes, 2 trialists commented that adding bumps to the coloured dials would be an improvement. No specific problems were identified, although a number of trialists reported never having used their thermostat with a colour dial at all over a 6-month period.

4.1.1.2 Intervention B

In only 3 homes, 1 trialist commented that light should be further away from the wall. Problems were centred around glare.

4.1.1.3 Intervention C

In a total of 6 homes, only 1 trialist highlighted the need for more handover and follow-on support, while others remarked instructions at handover were very clear. In terms of improvements 2 trialists commented that a hot water boost function for system boilers would have been useful, as this was not a command recognised by Alexa. Another 2 trialists commented the inability to set schedules with voice commands was a limitation, though 1 trialist commented how he had managed to achieve this via the Honeywell App using audio software that vocalises the options. The same trialist commented on the ability to controlling heating while outside the home.

4.1.1.4 Intervention D

Deployed in 2 homes without an internet connection, feedback from one was "fabulous" and that there were no problems or possible improvements. While the other home remarked that more detailed explanation and handover at the beginning would have been beneficial.

When specifically asked how "did you feel you understood how to use the new controls" only one home with intervention D replied with no. In this particular home within intervention D, the schedule had been set by the installer, the project manager at post-install check and latterly again by the project manager at the post-installation survey visit. Despite continued offers and demonstrations the trialist and his wife were happy with the schedule and getting help from family members.

Trialists were asked "how easy is it too heat your home to a satisfactory level" on a scale of very easy, easy, difficult, very difficult. Before the intervention 4 homes reported it be difficult, the same homes after installation reported this to be easy or very easy.

4.2 Temperature logging

Datalogging equipment (Figure 5) was deployed at the pre-install visits and recovered at the post-install. This obtained temperature readings in the living room, hall and master bedroom at 2-minute intervals across the 17 homes. This has provided valuable data on how trialists heat their homes both before and after having an intervention installed.

To illustrate how the interventions A-D (3.1.2.1) impacted on how trialists were able to control their heating throughout heating season, 10 days were selected when the temperature did not differ more 0.5°C before and after the installation and the outside temperature was between 3°C and 6°C.

For a variety of reasons, the hall and master bedroom datasets were discounted and the living room dataset was analysed; the mean, median and standard deviation was calculated.

Table 5 – Mean, median and standard deviation living room temperature variation pre and post installation

Intervention	Pre-install			Post-install			Difference		
	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD
A	20.4	20.5	1.1	19.6	19.7	1.3	-4%	-4%	13%
B	21.3	21.1	0.8	21.1	21.0	0.8	-1%	-1%	-6%
C	19.8	19.9	1.0	19.3	19.4	1.0	-2%	-2%	-4%
D	20.4	20.5	1.1	19.6	19.7	1.3	-4%	-4%	13%

Considering the same size was small (Table 2) detailed statistically analysis was not possible.

In broad terms, across all interventions trialists would appear to be more engaged with their heating with both the mean and median lower after the intervention was installed. The standard deviation is the same or higher inferring there was similar if not greater variability with living room temperature post-installation.

Figure 8 below illustrates how median living room temperature was lower after the installation all measures A-D, although due with the small sample size (Table 2) no hard conclusions can be derived.

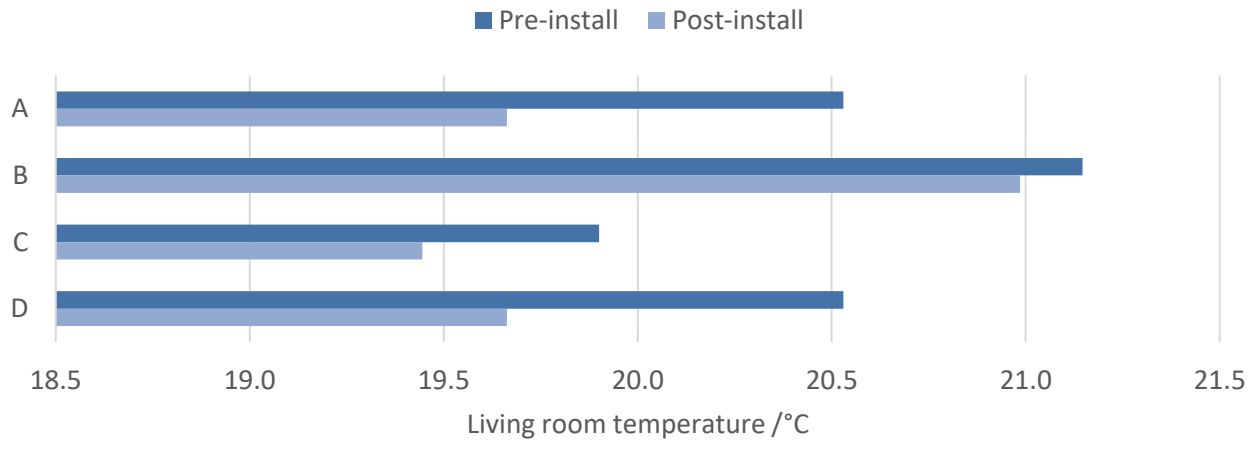

Figure 8 – Median living room temperature pre and post measure installation

5 Conclusions & recommendations

Despite the best efforts of NCBA and NDE starting with 30 initial recruits, this fell to an installation schedule of 26 homes and ultimately to 17 homes where the intervention equipment remained installed for the duration of the trial (3.1).

Trialist expectations varied and intervention selection was overridden by the necessity to install an intervention that the trialist would accept. Despite these efforts, this still resulted in 4 homes where interventions were refused (3.1.2.3).

Unexpectedly two trialists became unreachable during the installation phase of the trial (3.1.2.4) and at three homes couldn't participate for a variety of reasons (3.1.2.5).

Consequently, the sample size for some interventions was particularly low (Table 2), specifically intervention B was installed in 3 homes and intervention D in 2 homes.

There was also another home where the trialist participated fully, but there were problems during the installation of intervention D, which caused damage to the boiler. This resulted in additional cost, but the issue was resolved quickly and efficiently, as acknowledged by a thank you letter from home 22 (Figure 9).

Unfortunately, the temperature datasets collected have not revealed any particular insight into how trialists across different interventions were better able to control their heating.

Anecdotally, across the interventions, the coloured dial (intervention A) did not seem to provide any measurable benefit and was rejected by a number of trialists at the day of installation.

Similarly, with task lighting (intervention B), those who did take accept the intervention were latterly neutral or negative about it, and asked during the post-install visit for the intervention to be removed as it provided no benefit to them.

The large display thermostat (intervention D) ultimately was deployed to those homes where there was no internet connection, critically trialists were not using the controls and relied on relatives to make changes.

Alexa voice control with Honeywell Lyric (intervention C) was almost universally liked with several trialists buying smart plugs and extending functionality to also control lighting.

5.1 Next steps

It was clear that Alexa voice control with Honeywell Lyric (intervention C) was the best option for any trialist regardless on the level of their visual impairment, although this was contingent on an internet connection.

A larger field trial that starts earlier in the heating season from September rather than March could help establish a more robust understanding of how Alexa voice control with Honeywell Lyric (intervention C) benefits those with a visual impairment. A greater sample size would also allow for a more statistically significant analysis of temperature logging data to be carried out, which would help to quantify the degree in which those with visual impairment can better control and manage the heating in their home.

A range of other interventions could be designed and built following the feedback and understanding gained from the deployment of interventions A & B. This would provide alternative options to those who either did not want voice control or were without an internet connection.

6 Appendices

15 MARCH 2019

DEAR NAREC
Re:

THANK YOU FOR COMING ON 13 MARCH TO INSTALL MY HEATING CONTROL THERMOSTAT. AFTER A PROBLEM WITH THE BOILER AN ENGINEER FROM 0800 REPAIR CAME TO PUT THE BOILER BACK INTO SERVICE.
I AM VERY IMPRESSED WITH YOURSELVES AT NAREC AS YOU KEPT ME WELL INFORMED AS TO HOW MY BOILER WAS GOING TO BE REPAIRED.
0800 REPAIR CAME 14 MARCH TO INSTALL A NEW CIRCUIT BOARD AND TO SHOW ME THE WORKINGS OF THE NEW THERMOSTAT.
THANK YOU TO SHAUN AND THE

MANAGER OF NAREC FOR BEING SO EFFICIENT.
MY HEATING SYSTEM IS NOW 100%

KIND REGARDS

Figure 9 – Thank you letter from home 22

Advancing Renewable Energy

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