Part 2. Comparative survey of Tees Valley residents' and national responses to low-carbon technologies in the home

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Executive summary

A quantitative online survey study was conducted of the acceptance domestic low-carbon technologies in the Tees Valley sub-region and the collective other English sub-regions. This study measures some of the factors that emerged from the preceding interview study, and develops and tests a model of a technology acceptance model using the theory of planned behaviour.

Two versions of an online survey were created: one presenting a retrofit low-carbon home and another presenting a new-build low-carbon home. In response to the presentation, 3813 participants (823 from Teesside; 3530 from other English sub-regions) answered questions regarding the acceptance of changing to a low-carbon home in terms of behavioural intention to change, attitude, subjective norm (social influence) and perceived behavioural control as well as willingness to pay and willingness to accept. They also answered questions about their demographics and their current housing as well as their current use of low-carbon technologies. The data were analysed with descriptive statistics, and with multiple regression analysis and logistic regression analysis to predict acceptance outcomes.

Behaviour-related outcomes. The results across the four main behaviour-related outcomes are mixed, but the pattern is the same for Teesside and England outside Teesside. Attitude towards low-carbon technology was most positive. Perceived behavioural control was middling/high. Behavioural intention was middling. Social influence was middling/low.

Behaviour-related outcome		Teesside	England (outside Teesside)
Behavioural intention	Willingness to change	±	±
Attitude	Feeling about change	+	+
Subjective norm	Social influence on change	-/±	-/±
Perceived behavioural control	Control over change	+/±[a]	+/±[a]

[a]Higher for owners than for renters.

Outcomes of changing to a low-carbon home. Participants provided ratings of their behavioural beliefs: the likelihood that specific outcomes would occur as a result of them changing to a low-carbon home. They also provided ratings of their outcome evaluations: the extent to which they judged specific outcomes as bad or good. The results for behavioural beliefs (about the likelihood of outcome occurring) and outcome evaluations (good/bad) varied across outcomes, from bad unlikely outcomes (for example increase in energy bills) to good likely outcomes (for example health improved).

Likelihood - /evaluation -	Likelihood ± /evaluation -	Likelihood + /evaluation -	Likelihood + /evaluation +
Increase in energy bills	Reduction of indoor living space	Rent increase	Reduction in energy bills
Reduced availability of hot water and electricity			Health improved
			Well-being improved
			Environment improved
			Others encouraged
			Reliable energy supply
			Feeling virtuous
			Feeling secure

Social influence. Participants rated significant others' (for example family members') social expectations of them changing to a low-carbon home. Participants also rated their motivation to comply with these others' expectations. Furthermore, participants rated significant others' (for example family members') social behaviour in terms of these others changing to a low-carbon home. Participants also rated their identification with these significant others. The results for motivation to comply/social expectations and identification/social behaviour varied across sources of influence. For example, those participants believed that family and friends wanted them to change to a low-carbon home, but had not themselves changed to a low-carbon home.

Motivation to comply -/±/ social expectation +	Motivation to comply ± /social expectation ±/+	Identification -/± /social behaviour -
Family/friends	Landlord/housing association	Family/friends
		Fellow residents

Control. Participants rated the strength of control beliefs: the likelihood that specific control factors would occur that would facilitate or hinder them in changing to a low-carbon home. They also rated the power of control factors: the strength of specific facilitators or barriers to them making the change to a low-carbon home. Results for strength of control belief and power varied across control factors, from high likelihood and power (for example, accessibility of low-carbon technologies) to middling likelihood and power (for example insufficient knowledge).

Likelihood ± /power +	Likelihood + /power +	Likelihood ± /power +	Likelihood ± /power ±	Likelihood +/± /power -/±
Government support	Affordability	Insufficient space	Disruption	Heat pump visually unappealing
	Accessibility	Difficulty of repair	Insufficient knowledge	

Predictors of outcome variables. For each of the main outcomes, specific statistically significant positive (+) and negative (-) predictors were identified.

Outcome	Behavioural intention /willingness to change	Attitude /feeling about change	Subjective norm /social influence on change	Perceived behaviour control /control over change
Predictors	Attitude + Subjective norm + Perceived behavioural control +	Reduced energy bills + Improved health + Improved well-being + Environmental benefit + Encouragement of others + Reliability/energy supply + Feeling virtuous + Feeling secure + New build + Education + Smart meter installed +	Family social expectation + Family behaviour + Non-white ethnicity + Solar installed + Additional insulation + Smart meter installed + Disability - Employment + Landlord's expectation + Residents' behaviour +	Government support + Accessibility of LCT + Affordability of LCT + Insufficient space - Disruption - Difficulty of repair - Insufficient knowledge - New build + Age - Woman - Non-white ethnicity + Disability - Employment + (Semi-)detached home Solar installation + Additional insulation + Smart-meter installation +

Note. LCT: low-carbon technologies.

Willingness to pay/accept. Willingness to pay by owners for new build was higher (mean just under £30000) than for retrofit (mean below £5000). This may have been because the survey asked either about the additional cost to buy a home with low-carbon technologies installed (new build) or about the additional cost for upgrading their existing home with low-carbon technologies (retrofit). Willingness to pay (mean around £50) by renters (in terms of rent increase) was, again, higher for a new-build home than for a retrofit home.

The value that respondents placed on low-carbon technologies was lower when measured as willing to pay (WTP) for the whole package of low-carbon technologies than when measured as willingness to accept (WTA). The sum of individual aspects of low-carbon technologies. WTP was 20% of WTA for renters, 34% to 52% for owners/retrofit and 70% to 78% for owners/new build.

Predictors of willingness to pay/willingness to accept. The most consistent predictors of willingness to pay and willingness to accept were non-white ethnicity (higher willingness) and age (willingness decreasing with increasing age). Furthermore, willingness to accept solar generation was lower for those already having solar generation installed. Similarly, willingness for smart-meter installation was lower for those already have a smart meter installed. Therefore, presumably from their experience with these technologies, these users had developed a more realistic estimate.

	Willingness to pay	Willingness to accept		
Outcome		Larger radiators	Reduced storage	Reduced outdoor space
Predictors	Non-white ethnicity + Age - (semi-) detached home +	Non-white ethnicity + Age - Solar installed + Bedrooms - Disability -	Non-white ethnicity + Age - Solar installed +	Non-white ethnicity + Employment + Woman + Additional insulation +

Outcome	Willingness to accept				
	Additional insulation	Heat pump	Smart meter	Battery energy storage	Solar generation
Predictors	Non-white ethnicity + Age - Bedrooms - Employment + Woman + Additional insulation installed -	Non-white ethnicity + Age - Solar installed + Bedrooms - Woman +	Non-white ethnicity + Age - Bedrooms - Employment + Smart meter installed -	Non-white ethnicity + Age -	Non-white ethnicity + Age - Solar installed - (semi-) detached home +

Current use of low-carbon technologies. The diffusion of additional insulation and smart meters was relatively high (60% to 70%). The diffusion of solar generation (11% to 14%) and battery energy storage was relatively low (7%).

Predictors of current use of low-carbon technologies. Predictors of the current use of low-carbon technologies varied considerably between the technologies. The most consistent non-technology predictor was number of bedrooms, a potential indicator of affluence.

Outcome	Smart-meter installation	Additional home insulation	Solar installation
Predictor	Homeowner + Employment + (Semi-)detached home + Additional home insulation - Disability - Education +	Age + Bedrooms + (Semi-)detached home + Solar installation + Smart-meter installation +	Age - Bedrooms + Woman - Non-white ethnicity + Disability - (Semi-)detached home + Additional home insulation + Smart-meter installation +

Recommendations for Thirteen and other housing providers. In terms of main behaviour-related outcomes, it would be important to increase residents' intention to change by increasing social influence and perceived behavioural control. This is because intention was middling (neither high nor low), while social influence was middling/low and perceived behavioural control was middling/high. Attitude was highly positive and therefore would not require the attention that the other outcomes do.

According to our regression analysis results, social influence can potentially be enhanced by engaging with people with certain characteristics, such as those without solar generation installed and unemployed people. Efforts to enhance social influence through family member's expectations and behaviour, landlords' expectations and fellows residents' may be challenging, as motivation to comply and identification were low or middling.

Also according to our regression analysis results, perceived behavioural control can potentially be enhanced by emphasising various factors in communication, such as accessibility of low-carbon technologies and their affordability. Perceived behavioural control can potentially be further enhanced by engaging with people with certain characteristics, such as older people and less affluent people.

Furthermore, according to our regression analysis results, attitude can potentially be enhanced by emphasising various factors in communication, such as reduced energy bills, improved health and improved well-being. Attitude can potentially be further enhanced by engaging with people with certain characteristics such as people with lower education level lower and those without a smart meter installed.

From the perspective of using willingness to pay for/willingness to accept low-carbon technologies, according to our regression analysis results, acceptance can potentially be enhanced especially by engaging with people with certain characteristics such as less affluent people.

From the perspective of existing use of low-carbon technologies, according to our logistic regression analysis results, acceptance can potentially be enhanced by engaging with people with certain characteristics such as less affluent people.

1 Introduction

Here we report a quantitative online survey study of the acceptance domestic low-carbon technologies in the Tees Valley and other parts of the United Kingdom. This study measures some of the factors that emerged from the interview study as well as develops and tests a model of a technology acceptance model using the theory of planned behaviour.

1.1 Theory of Planned Behaviour

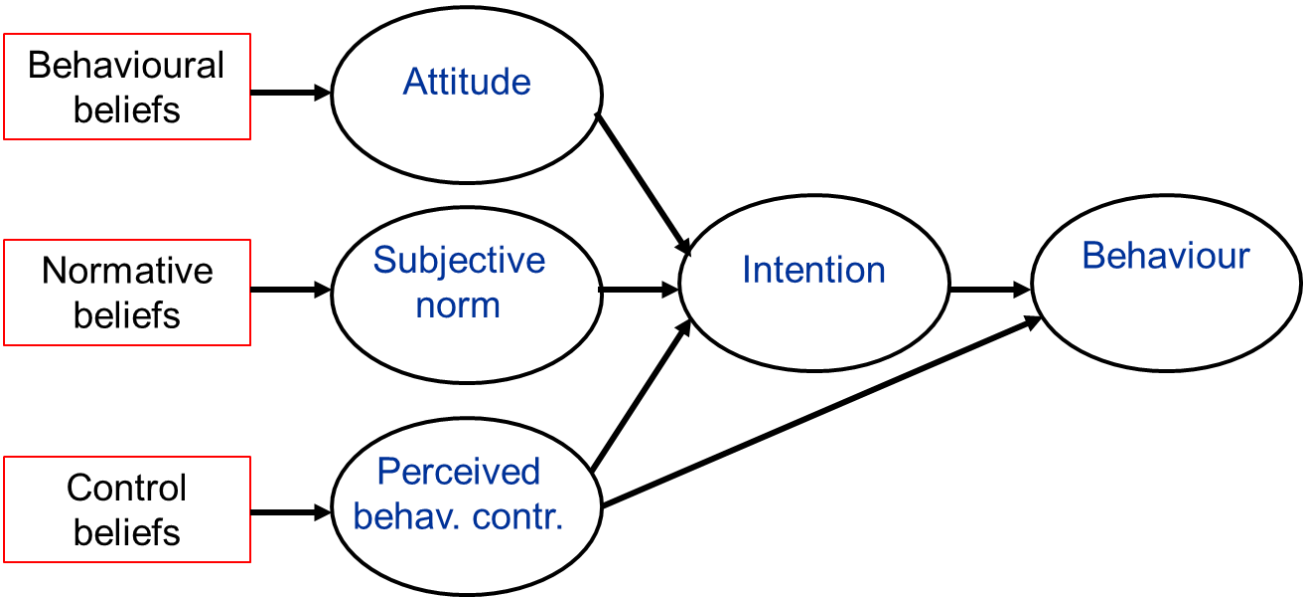
The intention of this research was to contribute to knowledge about the acceptance of domestic low-carbon technologies in the context of the Tees Valley sub-region and the collective other English sub-regions as a comparison. Psychological theories and models such as the theory of planned behaviour provide tools allow us to qualitatively identify beliefs that guide human behaviour with technology and subsequently quantitatively predict behaviour. As Ajzen (2020) explains, an advantage of the theory of planned behaviour is its proven wide applicability across various domains (including health, education and housing) and its flexibility in terms of adding specific model factors (for example specific facilitators and barriers) within its general structure. Therefore, the theory of planned behaviour (Ajzen 2020) was chosen as a theoretical framework. According to the theory of planned behaviour (see Figure 1), human behaviour is guided by three kinds of considerations: behavioural beliefs, normative beliefs, and control beliefs. Behavioural beliefs are about likely consequences of and experiences with a specific behaviour, and influence people's attitude towards a specific behaviour. Normative beliefs are about normative expectations and the behaviour of significant others and influence subjective norm (people's evaluation of influence of significant others on their behaviour). Control beliefs are about factors that may facilitate or impede engaging in the specific behaviour and influence perceived behavioural control. In turn, attitude, subjective norm (social influence) and perceived behavioural control influence behavioural intention (for example, intention to change to a low-carbon home). Ultimately, both behavioural intention and perceived behavioural control influence behaviour (for example, changing to a low-carbon home).

1.2 The current study

This research was conducted as the second stage of the Community Renewal Fund project. The social-housing provider Thirteen Group worked with a research team at Teesside University to enhance the capacity of the Tees Valley to transition to a net-zero emissions housing sector. The first aim of the first two stages of the current research is therefore to identify beliefs that potentially guide social-housing residents' future behaviour with domestic low-carbon technology. The objectives are to identify behavioural beliefs, normative beliefs and control beliefs that may underly residents' behaviour with domestic low-carbon technology according to the theory of planned behaviour (Ajzen, 2019), as well as any other beliefs. The research related to this aim is presented in the project's Stage 1 report. The second aim is to develop a model of citizens' acceptance of domestic low-carbon technologies with data from residents. The research related to this aim is presented in this report.

Figure 1

Theory of planned behaviour
Source: White, K. M., Jimmieson, N. L., Obst, P. L., Gee, P., Haneman, L., O'Brien-McInally, B., & Cockshaw, W. (2016). Identifying safety beliefs among Australian electrical workers. *Safety science, 82*, 164-173.



2 Methods

2.1 Research Design

A quasi-experimental survey design was used. The main outcomes were acceptance variables: behavioural intention, attitude, subjective norm (social influence) and perceived behavioural control (all four from the theory of planned behaviour) as well as, willingness to pay and willingness to accept, and current use of low-carbon technologies.

The independent variable was residential-decarbonisation intervention. The levels were retrofit and new build (see Figure 2). The main covariates were current home-ownership status of respondent (the main statuses were renter and owner; other statuses were living with friend/family and other), current housing type of respondent and United Kingdom (UK) sub-region (Teesside sub-region and the collective English sub-regions outside of Teesside). Further covariates were demographics and house size (number of bedrooms). Current low-carbon technology use was also a covariate for the other outcome variables.

2.2 Participants, housing and low-carbon technology

Participants were recruited through the online survey panel service Pure Profile, separately targeting Teesside sub-region and the collective English sub-regions outside Teesside. From initial discussion with the service, the expected maximum potential Teesside sample size would be 200

to 300. Therefore, it was decided to collect as many responses as possible from Teesside and then to match the English sample as close as possible with the Teesside sample. There were 3813 participants. Demographics are presented in Figure 3. Descriptives for housing are presented in Figure 4.

The sample of English respondents outside Teesside (3530) was more than 10 times larger than the Teesside sample (283). Therefore, the data sets for Teesside and England outside Teesside were analysed separately.

Overall, the pattern shown in Figures 2, 3 and 4 was similar across Teesside and England outside of Teesside. On most of the variables (demographic, housing-related and low-carbon technology-related) the match was within 5% for each variable category.

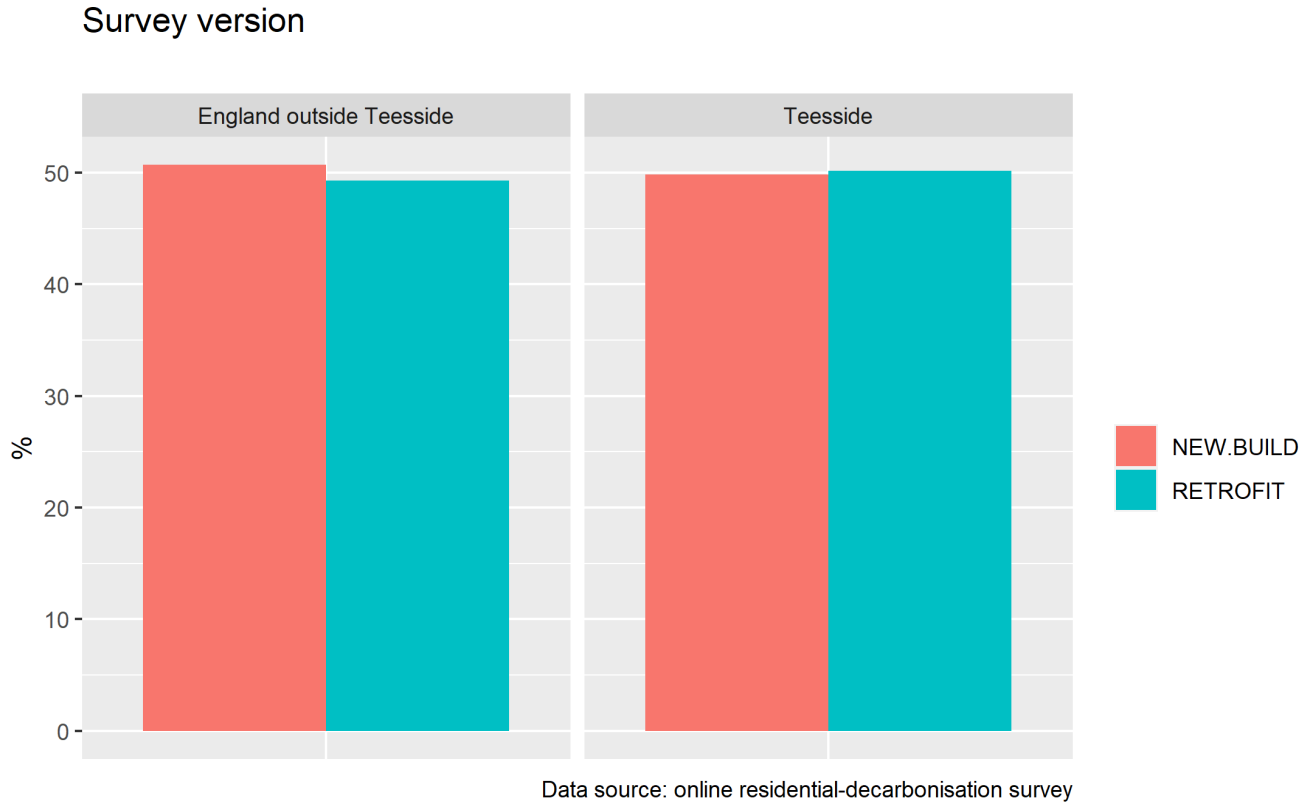
Mean age was about 50 years old. A majority of respondents was female (about 60%) or male (about 40%). Of the total sample 94% was of white ethnicity. A majority reported to have no disability, but about 20% reported some limitations in day-to-day activities and less than 10% a lot of limitations. The most common highest levels of education were – in order – degree, A-level and GCSE. Most respondents were employed or retired. The third-most frequent employment status was unfit to work. The most common house types were semi-detached, detached and mid-terrace. The most common homeownership was self-owned/mortgaged, closely follows by rented (privately or through social housing). The most frequent (modal) number of bedrooms was 3, with a mean of 2.86 and standard deviation of 1.05.

2.3 Materials and equipment

An online survey (see appendix A) was created in JISC Online surveys (*https://www.jisc.ac.uk/online-surveys*). Demographic items included gender, age, education, work and disability. Housing items were house type, owner status and house size (bedrooms). Further questions asked about current use of low-carbon technologies (solar panels, battery energy storage, heat pump, smart meter). Theory-of-planned behaviour (TPB) components were measured with items according to existing guidelines (*https://people.umass.edu/aizen/pdf/tpb.measurement.pdf*). Questionnaire items related to behavioural beliefs, normative beliefs, and control beliefs were created from the results of a previous qualitative study within this project (Stage 1 report). The items for the core TPB constructs (behavioural intention, attitude towards behaviour, subjective norm and perceived behavioural control) were subjected to exploratory factor analysis, with principal-axis extraction and direct oblimin rotation. A four-factor solution was identified (Table 1), after six items with poor loadings or cross-loadings (2 items for behavioural intention, attitude and subjective norm, each) were removed Reliability analysis was conducted on the remaining items within each factor as a scale. The four scales intention, attitude, subjective norm and perceived behavioural control were each reliable (Table 1). Next, for each of the core constructs scale scores were calculated as unweighted averages. These scores were used in subsequent analysis.

Figure 2

Survey version



2.4 Procedure

Participants completed the survey online as follows. After presentation of the study information and online consent by participants, they completed demographics questions, housing-related questions and questions related to their current use of low-carbon technologies. Then, a video was presented showing the use of low-carbon technologies in either a new-build or an existing (retrofit) home, followed by a written testimony of the experience of living in a low-carbon home. Subsequently, they answered questions about their valuation of these technologies. Finally, they completed the TPB items.

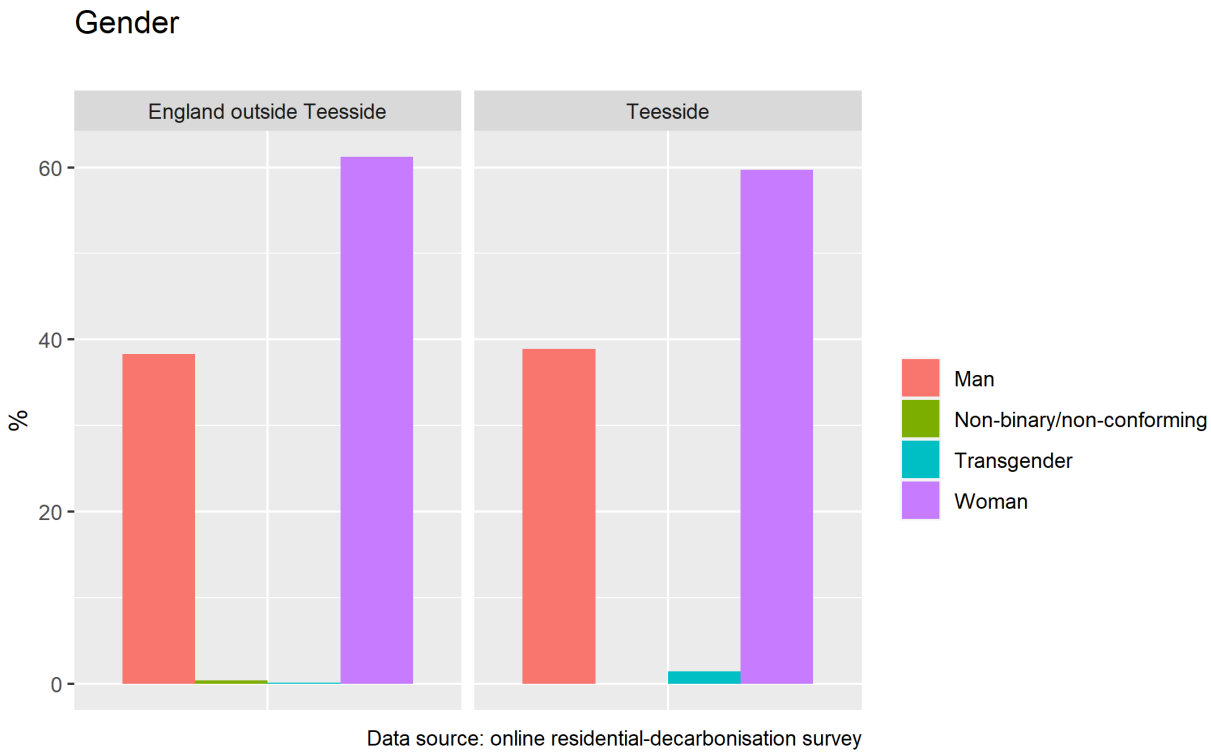
2.5 Data analysis

As the England sample was more than 10 times as large as the Teesside sample, analysis with inferential statistics was conducted within each sample separately, but not on differences between the samples.

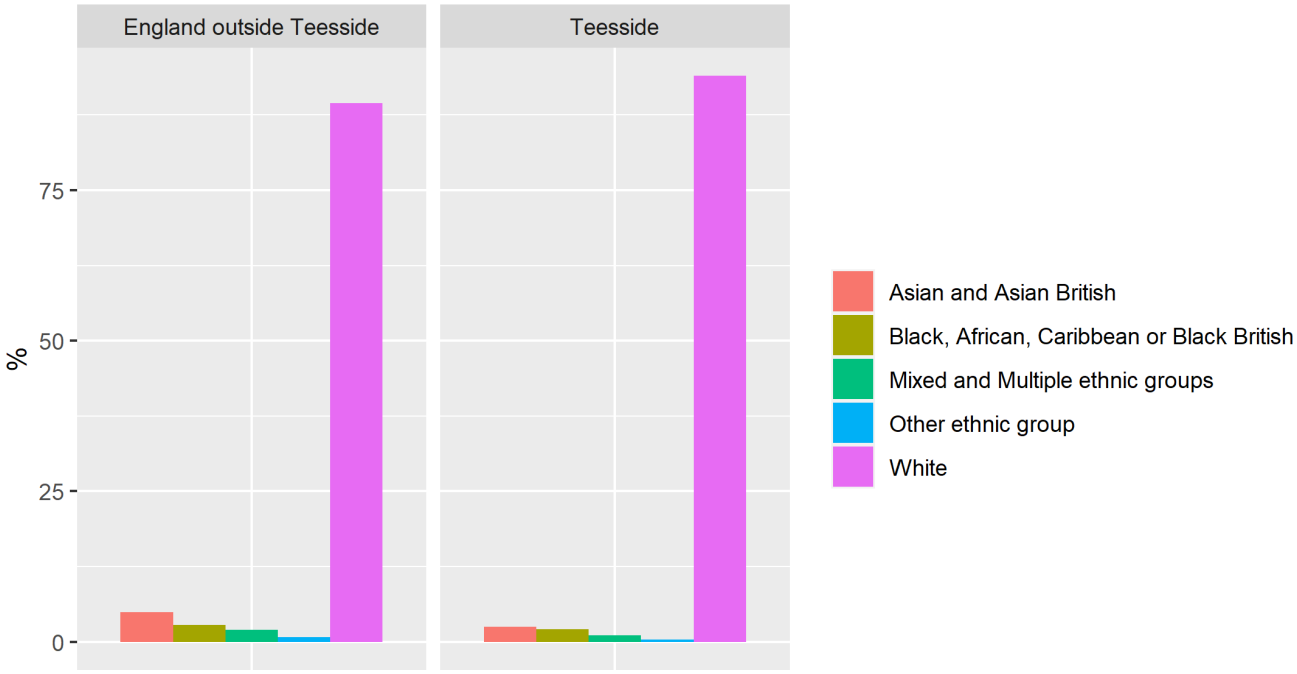
First, future acceptance of domestic low-carbon technologies was analysed according to the theory of planned behaviour (TPB). Descriptive statistics were calculated and graphs produced of the main TPB measured variables. Regression models were analysed to identify predictors of behavioural intention, attitude and subjective norm and perceived behavioural control.

Figure 3

Demographics

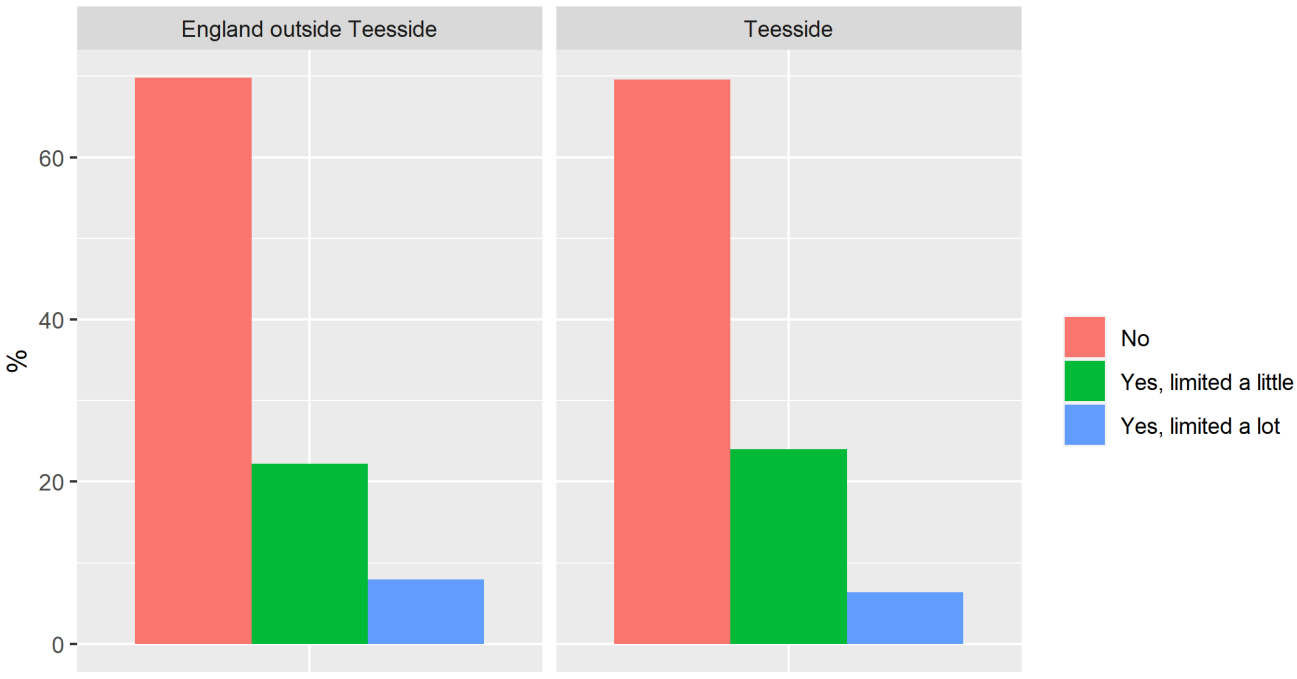


Ethnicity



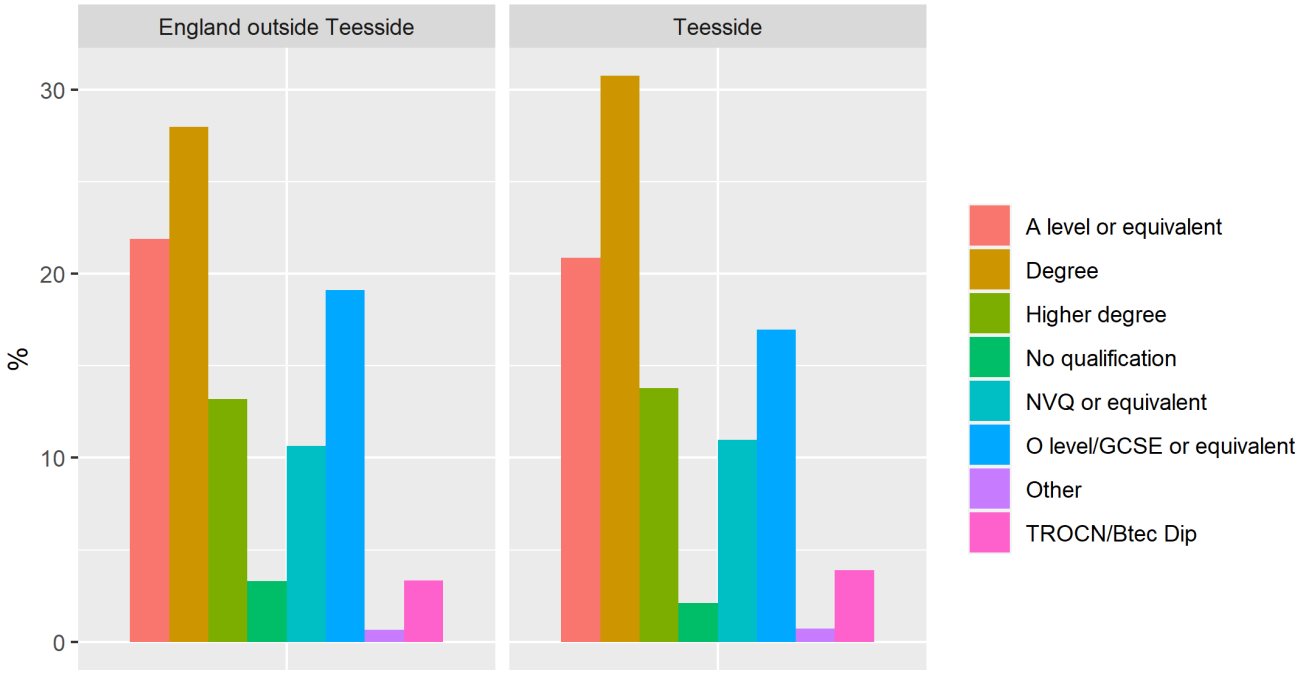
Data source: online residential-decarbonisation survey

Disability



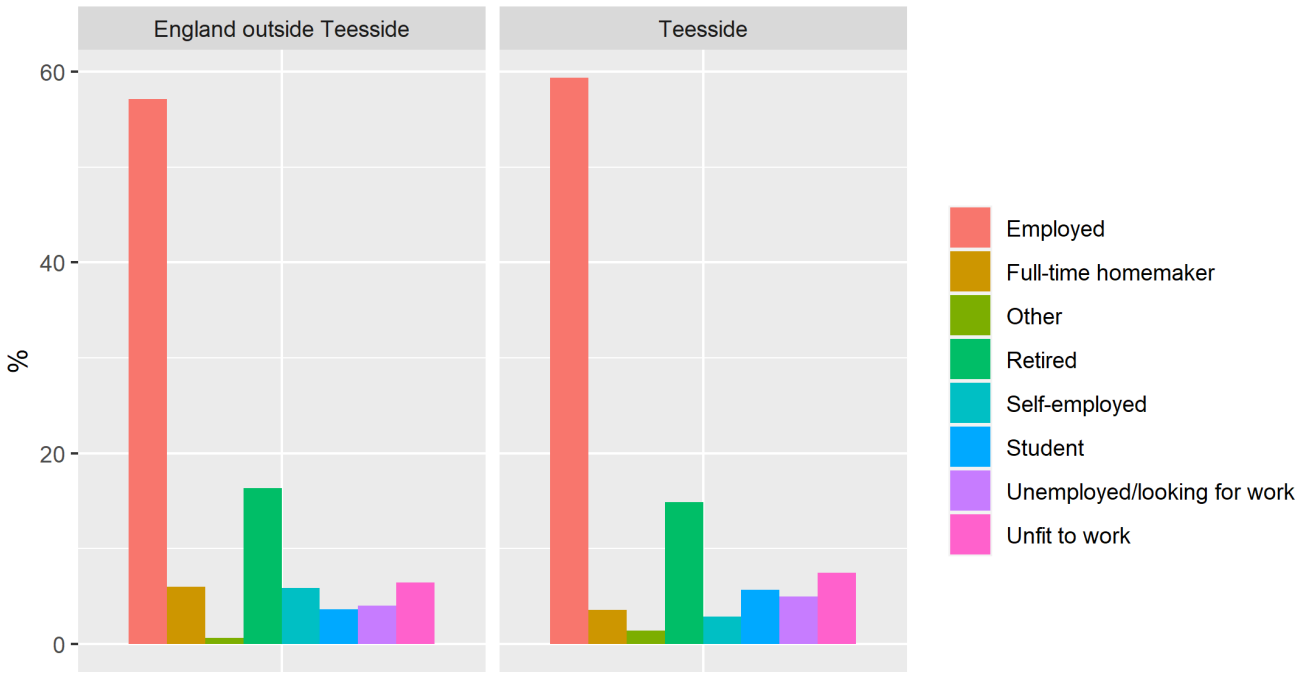
Data source: online residential-decarbonisation survey

Education



Data source: online residential-decarbonisation survey

Work

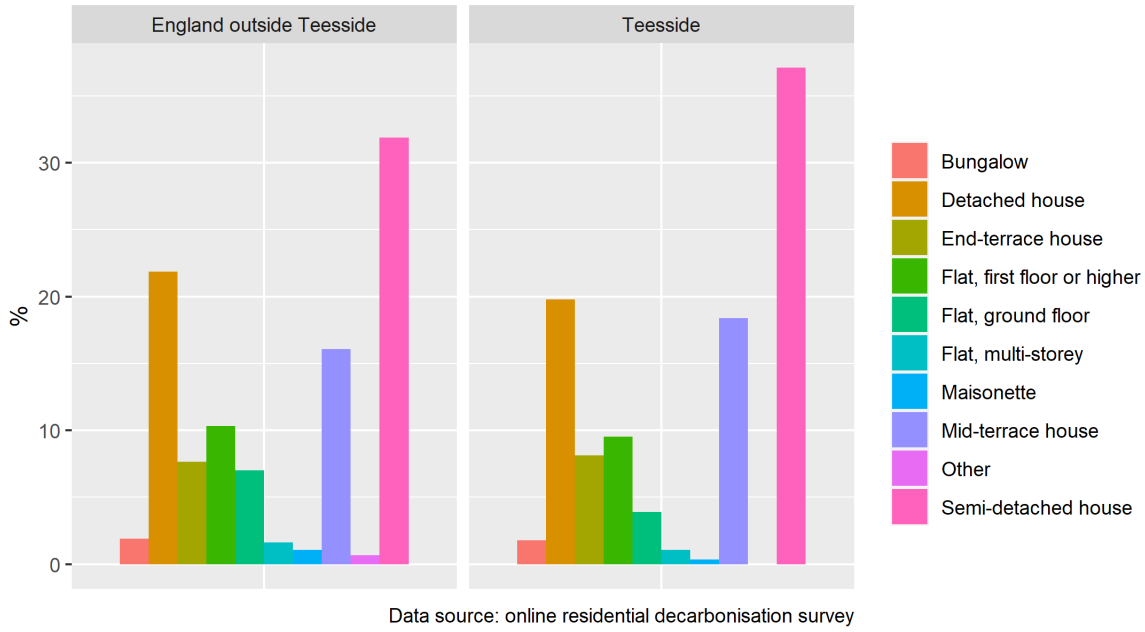


Data source: online residential-decarbonisation survey

Figure 4

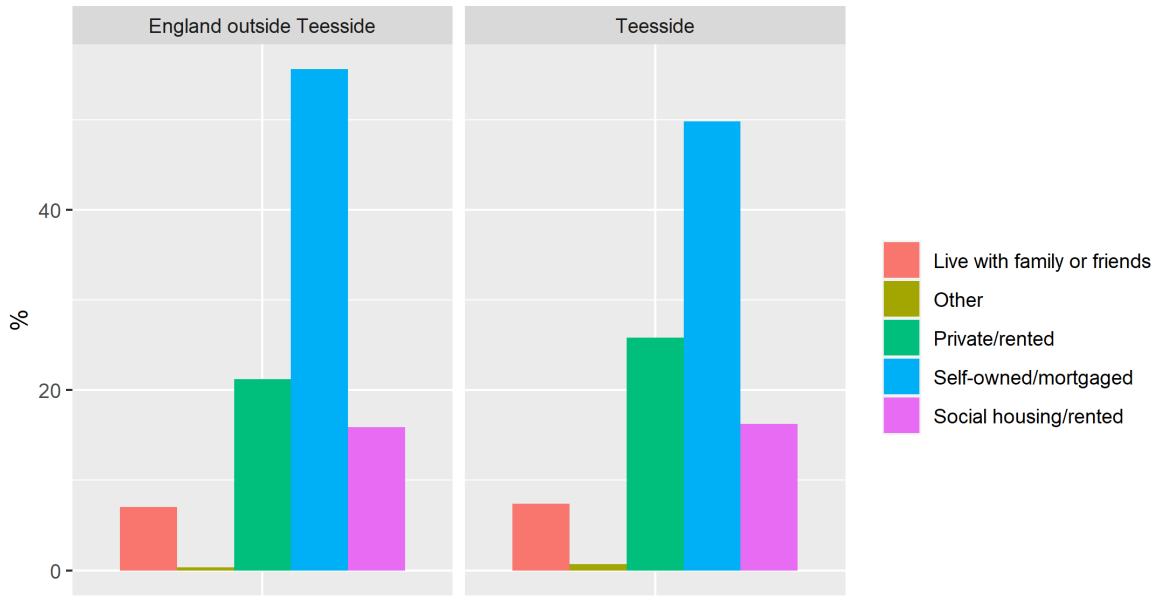
Housing

Home type



Data source: online residential decarbonisation survey

Home ownership



Data source: online residential decarbonisation survey

Second, to complement the first analysis, future acceptance was analysed as willingness to pay for domestic low-carbon technologies and as willingness to accept not having individual technology components of a low-carbon home. Descriptive statistics were calculated and regression models were analysed to identify predictors willingness to pay and willingness to accept.
Third, acceptance was analysed as current use of low-carbon technology was analysed in terms of descriptives and logistic-regression models were analysed to identify predictors of this acceptance.

3 Results

To facilitate interpretation, scale values were centred. Before centring, the original 7-point scale values had a range 1 through 7; after centring the range was -3 through to 3. Therefore, centred values below 0 indicate a negative/low response and centred values above 0 indicate a positive/high response. For statistical tests the significance level was set at 0.05.

3.1 Main components of the theory of planned behaviour

In both samples and for both homeownerships (owner and renter; Figure 5), behavioural intention to changing to a low-carbon home was middling (around the middle scale value of 0). Therefore, increasing intention will be important in the future. This may be possible for example by way of information provision. Attitude towards changing to a low-carbon home was positive (above the middle scale value). Subjective norm was slightly negative, but close to middling. However, perceived behavioural control was slightly positive, but close to middling.

3.2 Behavioural beliefs

Ratings of behavioural beliefs measured respondents' perceived likelihood of specific outcomes if they would switch to low-carbon technologies. Ratings of outcome evaluations measured their evaluation of these specific outcomes in terms how good or bad these outcomes would be for them. The results are presented graphically, for Teesside and England outside Teesside separately in Appendix B.
Mean scores on the following potential outcomes of changing to a low-carbon technology home showed that these were perceived as likely and evaluated as good, to varying degrees:

- reduction in energy bills;
- improvement in health;
- improvement in well-being;
- environmental protection through reduced energy use;
- encouragement to switch of other people;
- reliability of energy provision by way of solar panels;
- feeling virtuous by contributing to sustainability;
- feeling secure because of having a reliable energy source.

Mean scores on the following potential outcomes of changing to a low-carbon technology home showed that these were evaluated as bad, to varying degrees:

- increase of energy bills (perceived as unlikely);
- reduction in availability of hot water and electricity (perceived as unlikely);
- indoor living space reduced (perceived as neither likely nor unlikely);
- rent increased (perceived as likely).

Therefore, it will be important to avoid a rent increase, if possible or as much as possible, and communicate this to residents. Similarly, it will be important to communicate the extent to which installing a heat pump would reduce indoor living space.

3.3 Normative beliefs

Ratings of injunctive normative beliefs measured respondents' strength of belief that specific others would want them to switch to low-carbon technologies (social expectation). Ratings of motivation to comply measured the influence of these others' wishes on their own behaviour. Ratings of descriptive normative beliefs measured respondents' conviction that specific others had already switched to low-carbon technologies. Ratings of identification measured the influence of these others' behaviour on their own behaviour. The results are presented graphically, for Teesside and England outside Teesside separately in Appendix B.

Friends/family/neighbours (injunctive): the mean ratings show that normative beliefs were slightly above the (neutral) middle value (significant others wanted respondents to change to low-carbon technology), but motivation to comply relatively low.

Landlord/housing association (injunctive): the pattern of results was similar, but the normative beliefs were lower/closer to the middle value (neither negative nor positive) and motivation to comply was just above.

Regarding influence of others' behaviour: friends/family/neighbours (descriptive) and Residents renting from same landlord/housing association (descriptive): the findings suggest that these were unlikely to live in a low-carbon home and use low-carbon technologies, Moreover, their behaviour was unlikely to influence respondents' behaviour.

3.4 Control beliefs

Ratings of control beliefs measured respondents' perceived likelihood of specific factors that would facilitate or hinder them switching to low-carbon technologies. Ratings of the power of control factors measured their strength of these factors facilitating or hindering them switching. The results are presented graphically, for Teesside and England outside Teesside separately in Appendix B.

Government support was perceived as facilitating the switch to low-carbon technologies and – in particular by owners – as neither likely or unlikely to happen.

The accessibility of heat pump controls and the affordability to operate of the energy system were both perceived to be likely and to be facilitating.

Table 1

Exploratory factor analysis (structure matrix and variance explained) and reliability analysis

Panel A

Structure matrix, all core-construct items

Item	Factor 1	Factor 2	Factor 3	Factor 4
Q044Intention1	0.58	**0.38**	0.70	0.51
Q045Intention2	0.72	*0.18*	0.54	0.30
Q046Intention3	0.75	*0.18*	0.57	0.35
Q047Intention4	0.34	**0.39**	0.78	0.40
Q048Intention5	0.38	**0.37**	0.85	0.48
Q049Intention6	0.43	**0.40**	0.89	0.47
Q050Attitude1	**0.83**	0.20	0.43	0.24
Q051Attitude2	**0.83**	0.21	0.36	0.24
Q052Attitude3	**0.83**	0.20	0.35	0.17
Q053Attitude4	**0.77**	0.23	0.31	0.28
Q054Attitude5	**0.85**	0.22	0.43	0.26
Q055Attitude6	**0.79**	0.27	0.34	0.37
Q056Attitude7	**0.87**	0.20	0.34	0.25
Q057Attitude8	**0.84**	0.26	0.37	0.38
Q058NormI1	0.71	0.28	0.46	*0.50*
Q059NormI2	0.77	0.26	0.43	*0.41*
Q060NormI3	0.40	0.38	0.54	**0.72**
Q061NormD4	0.24	0.34	0.45	**0.59**
Q063NormD5	0.31	0.36	0.44	**0.88**
Q064NormD6	0.28	0.38	0.44	**0.90**
Q065PBC1	0.51	0.60	*0.65*	0.60
Q066PBC2	0.15	0.75	**0.23**	0.23
Q067PBC3	0.16	0.86	**0.31**	0.34
Q068PBC4	0.30	0.73	**0.49**	0.53
Q069PBC5	0.17	0.32	*0.22*	0.29
Q070PBC6	0.47	0.69	**0.53**	0.45
Q071PBC7	0.48	0.72	**0.61**	0.52
Q072PBC8	0.06	0.49	**0.18**	0.05

Panel B

Structure matrix, reduced core-construct items

Item	Factor 1	Factor 2	Factor 3	Factor 4
Q044Intention1	0.54	**0.41**	0.64	0.51
Q047Intention4	0.34	**0.40**	0.80	0.40
Q048Intention5	0.38	**0.38**	0.89	0.48
Q049Intention6	0.42	**0.40**	0.93	0.47
Q050Attitude1	**0.83**	0.21	0.43	0.24
Q051Attitude2	**0.84**	0.21	0.36	0.25
Q052Attitude3	**0.84**	0.20	0.35	0.18
Q053Attitude4	**0.79**	0.23	0.33	0.28
Q054Attitude5	**0.85**	0.23	0.42	0.27
Q055Attitude6	**0.81**	0.26	0.37	0.37
Q056Attitude7	**0.88**	0.20	0.35	0.24
Q057Attitude8	**0.85**	0.25	0.39	0.38
Q060NormI3	0.38	0.38	0.54	**0.71**
Q061NormD4	0.23	0.34	0.46	**0.59**
Q063NormD5	0.30	0.36	0.45	**0.89**
Q064NormD6	0.27	0.38	0.46	**0.91**
Q066PBC2	0.16	0.75	**0.26**	0.23
Q067PBC3	0.16	0.87	**0.34**	0.34
Q068PBC4	0.30	0.73	**0.50**	0.53
Q070PBC6	0.46	0.68	**0.52**	0.44
Q071PBC7	0.47	0.72	**0.60**	0.52
Q072PBC8	0.06	0.50	**0.18**	0.05
Eigenvalue	7.90	3.20	3.43	3.02
% variance	0.28	0.11	0.12	0.11
Omega (reliability)	0.70	0.97	0.88	0.92

Figure 5

Intention, attitude, norm and control – mean and 95%-confidence interval

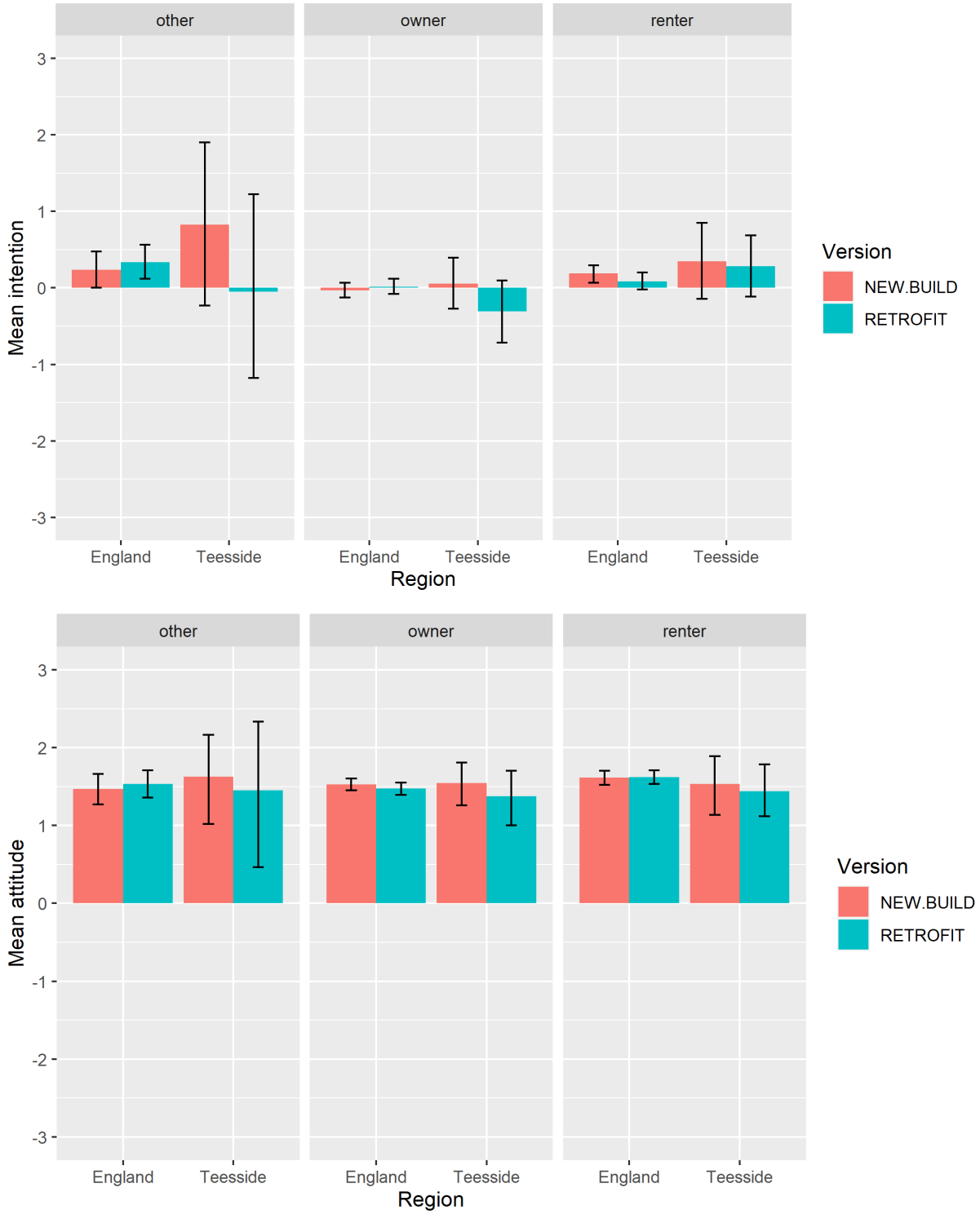
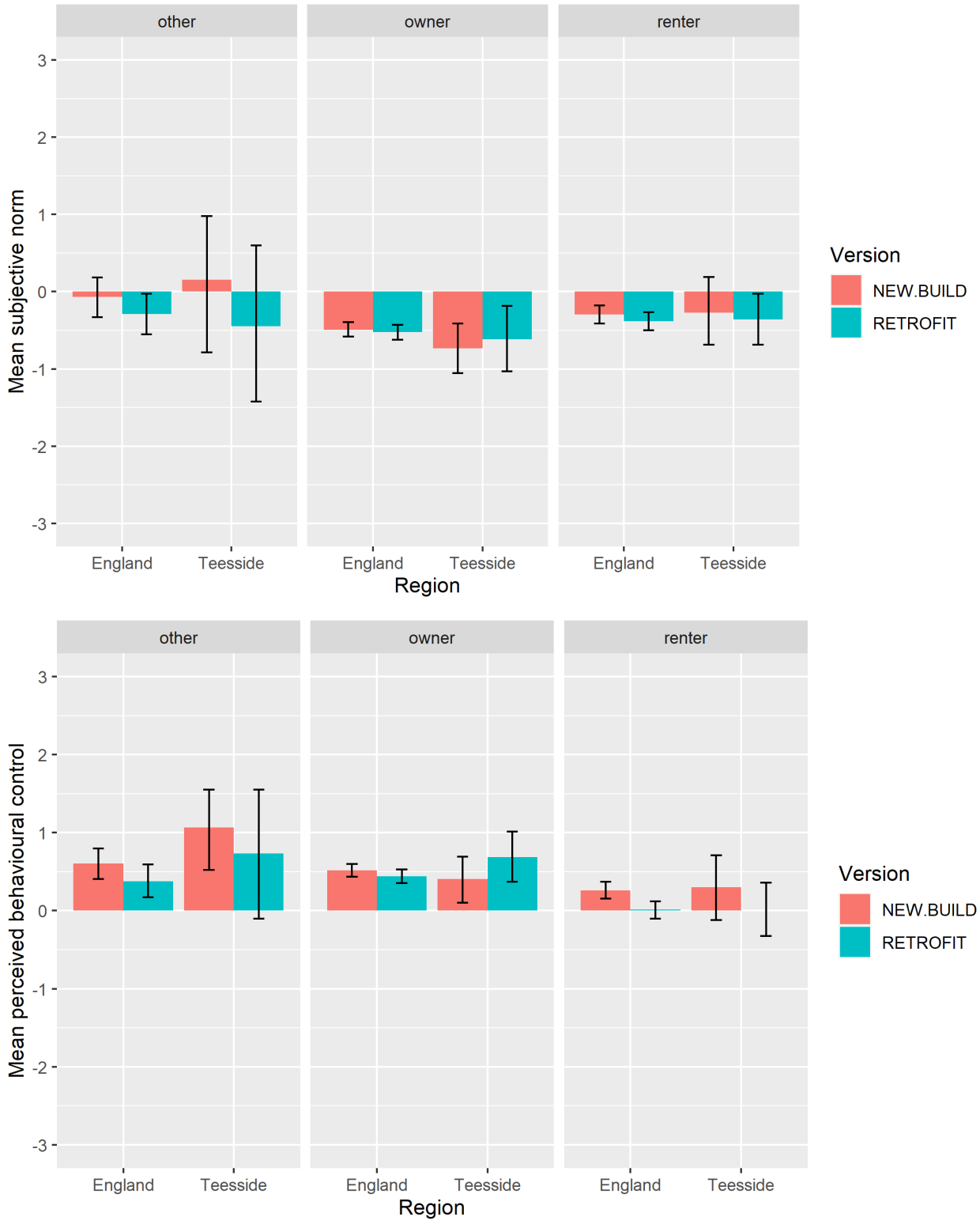


Figure 5 (continued)



The following potential barriers were perceived as neither likely nor unlikely, which indicates participants' uncertainty:

- insufficient space for storage tank (perceived as hindering the switch to some degree);
- disruption due to low-carbon technology installation (perceived as neither facilitating nor hindering);
- difficulty to arrange heat pump repair (perceived as hindering the switch to some degree);
- insufficient knowledge and skills to operate (perceived as neither facilitating nor hindering, except perceived as hindering the switch to minor for Teesside renters in retrofit homes).

These indications of uncertainty are important to consider, as uncertainty may lead to indecision (Arbona et al., 2021). Information provision that citizens accept as clear and credible may reduce this uncertainty.
Heat pump making exterior unappealing was rated as likely to some degree, but not to hinder the switch.

3.5 Associations of behavioural intention and related outcomes

Correlations between core TPB variables (acceptance variables), behavioural intention, attitude, subjective norm and perceived behavioural control, are reported here. Although it is important to realise that correlation does not imply causation, these correlations are potentially important as a basis for developing ideas to increase the acceptance of domestic low-carbon technologies. Nevertheless, some variables that are substantially correlated with acceptance may not be predictive of acceptance when analysed together with other variables, as shown in the following section.
Per acceptance variable, the correlations equal to or exceeding a threshold of 0.10 (10% variance overlap) are interpreted here, as these are considered as substantial (Tabachnick & Fidell, 2013). Exploration of the associations between core TPB variables and other variables showed the following patterns (see also Table 2).

3.5.1 England

Consistent with the theory of planned behaviour (TPB), behavioural intention was positively correlated with attitude, subjective norm and perceived behavioural control.
Attitude was positively correlated with positive outcomes of changing to a low-carbon home (for example, reduction in energy bills and improvement in health). However, attitude was not correlated with negative outcomes (for example, reduction in indoor space and increase in rent).
Subjective norm was strongly positive correlated with injunctive norms (for example from family/friends) and descriptive norms (for example, from other residents).
Perceived behavioural control was moderately positively correlated with facilitators (for example affordability of running low-carbon technologies), but not substantially negatively correlated with barriers (for example lack of knowledge to operate low-carbon technologies).

3.5.2 Teesside

The pattern of results for Teesside was the same as that for England. The exception was that age was substantially negatively correlated with behavioural intention and subjective norm.

3.6 Predicting behavioural intention and other main outcomes

Overall model results of multiple-regression analyses and logistic-regression analyses are presented in detail. For limitations of space, results per predictor are available on request.

3.6.1 Behavioural intention – full sample

3.6.1.1 England

The main outcome measure was behavioural intention. The analysis proceeded in four steps (through four corresponding models); at each step, one an additional predictor set was analysed. The predictor sets were, first, the core TPB variables attitudes, subjective norm and perceived behavioural control; second, multiplications of behavioural beliefs and outcome evaluations, normative beliefs and motivation to comply/identification and control beliefs and power of control factors (following guidance for analysing TPB models; Ajzen, 2020); third, low-carbon intervention (retrofit or new build); and fourth, demographic, housing-related and low-carbon technology-related variables.

Model 1: core TPB variables. The model explained 48% of variance in intention, $R^2 = 0.48$, and the model was a statistically significant improvement over using the mean of intention as a predictor, F (3, 3526) = 1065.00, $p < 0.001$. Perceived behaviour control, subjective norm and attitude were significant positive predictors. Intention increased with perceived control, subjective norm and attitude.

Model 2: adding behavioural beliefs/outcome evaluations, normative beliefs/motivation to comply/identification and control beliefs/power of control factors as predictors. The model explained an additional 1% of variance in intention, $\Delta R^2 = 0.01$ ($R^2 = 0.49$), and the model was a statistically significant improvement over Model 1, F (21, 3505) = 6.77, $p < 0.001$. Additional significant positive predictors were encouragement of others to change to domestic low-carbon technology, feeling virtuous as a result of changing, the behaviour of family/friends changing and affordability of low-carbon technology. Unappealingness of heat pump external was a significant negative predictor.

Model 3: adding low-carbon intervention as a predictor. The model explained an additional 0.1% of variance in intention, $\Delta R^2 = 0.001$ ($R^2 = 0.49$), and the model was a statistically significant improvement over Model 2, F (1, 3504) = 4.83, $p = 0.03$. Intention was higher was higher for decarbonisation in a new-build rather than a retrofit home.

Model 4: adding demographics, housing-related variables and current low-carbon technology use as predictors. The model explained an additional 2% of variance in intention, $\Delta R^2 = 0.02$ ($R^2 = 0.51$), and the model was a statistically significant improvement over Model 3, F (12, 3492) = 11.88, $p < 0.001$. Age was an additional significant negative predictor (intention lower with increasing age). Further significant predictors were ethnicity (non-white higher than white),

disability (non-disabled higher than disabled), employment status (employed higher than unemployed) and solar (higher for solar-users and non-users).

3.6.1.2 Teesside

The same analysis was conducted on the Teesside data as on the England data.
Model 1: core TPB variables. The model explained 55% of variance in intention, $R^2 = 0.55$, and the model was a statistically significant improvement over using the mean of intention as a predictor, F (3, 278) = 115.2, $p < 0.001$. Perceived behaviour control, subjective norm and attitude were significant positive predictors. Intention increased with perceived control, subjective norm and attitude.
Model 2: adding behavioural beliefs/outcome evaluations, normative beliefs/motivation to comply/identification and control beliefs/power of control factors. The model explained an additional 7% of variance in intention, $\Delta R^2 = 0.07$ ($R^2 = 0.62$) and the model was a statistically significant improvement over Model 1, F (21, 257) = 2.03, $p = 0.01$. Additional significant positive predictors were feeling virtuous as a result of changing to domestic low-carbon technology, reliability of low-carbon technology, the social influence of family/friends and difficulty of repairing heat pump, the latter possibly because of suppression. Additional significant negative predictors were disruption from installing low-carbon technology and environmental benefit, the latter possibly because of suppression.
Model 3: adding low-carbon intervention as a predictor. The model explained an additional 0.4% of variance in intention, $\Delta R^2 = 0.004$ ($R^2 = 0.62$), and the model was a marginally statistically significant improvement over Model 2, F (1, 256) = 2.82, $p = 0.09$. Intention was higher was higher for decarbonisation in a new-build rather than a retrofit home.
Model 4: adding demographics, housing-related variables and current low-carbon technology use. The model explained an additional 3% of variance in intention, $\Delta R^2 = 0.03$ ($R^2 = 0.65$), and the model was not a statistically significant improvement over Model 3, F (12, 244) = 1.43, $p = 0.15$.

3.6.2 Behavioural intention – subsample: renters

The main outcome measure was behavioural intention, this time for renters only and separately for England outside Teesside and for Teesside. The analysis of renters' data allowed us to examine variables that are specific to renters: first, rent increase, second, the influence of landlord and, third, the other residents' behaviour. As before, four models were analysed.
These analyses did not show any significant results for these specific variables. Therefore, given this lack of informativeness and for brevity, these results are therefore not presented here, but are available on request.

Table 2

Correlations

Variable	England				Teesside			
	INT	ATT	SN	PBC	INT	ATT	SN	PBC
Behavioural intention (INT)	1.00	0.47	0.58	0.53	1.00	0.56	0.67	0.49
Attitude (ATT)	**0.47**	1.00	0.35	0.33	**0.56**	1.00	0.44	0.41
Subjective norm (SN)	**0.58**	**0.35**	1.00	0.49	**0.67**	**0.44**	1.00	0.42
Perceived behavioural control (PBC)	**0.53**	**0.33**	**0.49**	1.00	**0.49**	**0.41**	**0.42**	1.00
version	0.00	-0.01	-0.02	-0.06	-0.08	-0.05	0.00	-0.02
Age	-0.27	-0.10	-0.21	-0.14	**-0.37**	-0.16	**-0.36**	-0.21
Bedrooms	0.06	0.00	0.02	0.14	0.02	0.10	0.00	0.21
Solar installed	0.17	0.06	0.20	0.17	0.19	0.11	0.22	0.17
Insulation installed	0.05	0.06	0.04	0.11	0.03	0.09	0.08	0.05
Smartmeter installed	0.12	0.15	0.11	0.12	0.09	0.13	0.05	0.08
Homeowner	-0.05	-0.04	-0.06	0.10	-0.13	-0.01	-0.13	0.10
Woman	-0.05	-0.06	0.01	0.06	0.02	-0.05	-0.03	0.07
Education, degree or higher	0.12	0.09	0.10	0.10	-0.04	0.06	0.03	0.00
Work, Employed	0.16	0.05	0.14	0.13	0.21	0.21	0.22	0.19
Home type, (semi-)detached	0.02	0.00	0.02	0.13	-0.02	0.07	-0.09	0.13
BillsReduced	0.32	***0.67***	0.17	0.27	0.38	***0.67***	**0.26**	**0.32**
Health	0.42	***0.65***	**0.35**	**0.32**	0.48	***0.66***	**0.45**	**0.37**
Wellbeing	0.45	***0.70***	**0.36**	**0.35**	0.51	***0.74***	**0.43**	**0.36**
Environment	0.35	***0.72***	**0.20**	**0.27**	0.35	***0.74***	0.21	0.30
EncourageOthers	0.50	***0.65***	**0.49**	**0.41**	0.58	***0.71***	**0.54**	**0.42**
ReliableEnergy	0.39	***0.69***	0.29	0.30	0.54	***0.75***	**0.42**	**0.37**
SustainableVirtuous	0.45	***0.68***	**0.37**	**0.34**	0.57	***0.72***	**0.46**	**0.32**
ReliableSecure	0.41	***0.72***	0.29	0.31	0.54	***0.73***	0.39	0.31
BillsIncreased	0.13	*-0.02*	0.31	0.11	0.21	*0.00*	**0.33**	0.18
EnergyReduced	0.11	*-0.02*	0.30	0.08	0.20	*0.07*	0.30	0.17
IndoorSpaceReduced	0.11	*0.00*	0.24	0.08	0.15	*0.07*	0.22	0.13
RentIncreased	0.08	*0.04*	0.20	0.11	0.15	*0.04*	0.21	0.20
FamilyInfluence	0.41	**0.34**	***0.57***	**0.32**	0.49	**0.38**	***0.55***	0.29
LandlordInfluence	0.35	**0.34**	***0.45***	0.30	0.46	**0.37**	***0.47***	0.31
FamilyBehaviour	0.38	0.19	***0.60***	**0.33**	0.42	0.27	***0.61***	**0.33**
ResidentsBehaviour	0.31	0.08	***0.52***	**0.35**	0.26	0.22	***0.53***	**0.32**
Government	0.34	**0.38**	**0.33**	***0.36***	0.35	**0.40**	0.30	***0.32***
LCTaccessible	0.36	**0.53**	0.21	***0.37***	0.37	**0.58**	0.24	***0.38***
LCTaffordable	0.39	**0.55**	0.26	***0.39***	0.40	**0.54**	0.30	***0.44***
SpaceInsufficient	-0.13	-0.14	-0.10	*-0.17*	-0.04	-0.11	-0.04	*-0.08*
Disruption	-0.26	**-0.35**	-0.17	*-0.24*	-0.30	**-0.44**	-0.19	*-0.28*
Repair	-0.25	**-0.32**	-0.21	*-0.25*	-0.22	**-0.39**	-0.23	*-0.25*
KnowledgeInsufficient	-0.11	-0.18	-0.04	*-0.15*	-0.04	-0.22	-0.03	*-0.05*
HeatPumpUnappealing	-0.23	-0.36	-0.14	*-0.17*	-0.21	-0.41	-0.10	*-0.14*

3.6.3 Attitude – full sample

3.6.3.1 England

Model 1: behavioural beliefs/outcome evaluations. The model explained 64% of variance in perceived behavioural control, $R^2 = 0.64$, and the model was a statistically significant improvement over using the mean of perceived control as a predictor, F (11, 3518) = 576.40, $p < 0.001$. Positive significant predictors were reduction in energy bills, improvement in health, improvement in well-being, environmental benefit, encouragement of others, reliability of energy supply, feeling virtuous as a result of changing and feeling secure because of having a reliable energy source.
Model 2: adding low-carbon intervention as a predictor. The model explained an additional 0% of variance in intention, $\Delta R^2 = 0.00$ ($R^2 = 0.64$), and the model was not a statistically significant improvement over Model 1, $F < 1$.
Model 3: adding demographics, housing-related variables and current low-carbon technology use. The model explained an additional 0.3% of variance in intention, $\Delta R^2 = 0.003$ ($R^2 = 0.65$), and the model was a statistically significant improvement over Model 2, F (12, 3505) = 2.75, $p < 0.001$. Age was an additional significant positive predictor (more positive attitude with increasing age), possibly because of suppression. Additional significant predictors were education (more positive with degree or higher degree) and smart meter installation (more positive with smart meter installed).

3.6.3.2 Teesside

Model 1: behavioural beliefs/outcome evaluations. The model explained 73% of variance in perceived behavioural control, $R^2 = 0.73$, and the model was a statistically significant improvement over using the mean of perceived control as a predictor, F (11, 270) = 67.33, $p < 0.001$. Positive significant predictors were reduction in energy bills, improvement in well-being, environmental benefit, encouragement of others, reliability of energy supply and feeling secure because of having a reliable energy source.
Model 2: adding low-carbon intervention as a predictor. The model explained an additional 0% of variance in intention, $\Delta R^2 = 0.00$ ($R^2 = 0.73$), and the model was not a statistically significant improvement over Model 1, $F < 1$.
Model 3: adding demographics, housing-related variables and current low-carbon technology use. The model explained an additional 1.2% of variance in intention, $\Delta R^2 = 0.012$ ($R^2 = 0.75$), and the model was not a statistically significant improvement over Model 2, $F < 1$.

3.6.4 Attitude – subsample: renters

The main outcome measure was behavioural intention, this time for renters only and separately for England outside Teesside and for Teesside. The analysis of renters' data allowed us to examine a variable that is specific to renters: rent increase. As before, three models were analysed. These analyses did not show any significant results for rent increase. Therefore, given this lack of informativeness and for brevity, these results are therefore not presented here, but are available on request.

3.6.5 Subjective norm– full sample

3.6.5.1 England

Model 1: injunctive/motivation to comply and descriptive beliefs/identification. The model explained 44% of variance in perceived behavioural control, $R^2 = 0.44$, and the model was a statistically significant improvement over using the mean of perceived control as a predictor, F (2, 3527) = 1400.00, $p < 0.001$. Positive significant predictors were family influence and family behaviour.
Model 2: adding low-carbon intervention as a predictor. The model explained an additional 0% of variance in intention, $\Delta R^2 = 0.00$ ($R^2 = 0.44$), and the model was not a statistically significant improvement over Model 1, $F < 1$.
Model 3: adding demographics, housing-related variables and current low-carbon technology use. The model explained an additional 2% of variance in intention, $\Delta R^2 = 0.02$ ($R^2 = 0.46$), and the model was a statistically significant improvement over Model 2, F (12, 3514) = 8.67, $p < 0.001$. Additional significant predictors were ethnicity (higher subjective norm for non-whites), employment (higher for employed), solar installation(higher with solar generation installed), additional insulation (higher with insulation) and smart meter installation (higher with smart meter installed).

3.6.5.2 Teesside

Model 1: injunctive/motivation to comply and descriptive beliefs/identification. The model explained 46% of variance in perceived behavioural control, $R^2 = 0.46$, and the model was a statistically significant improvement over using the mean of perceived control as a predictor, F (2, 279) = 118.50, $p < 0.001$. Positive significant predictors were family influence and family behaviour.
Model 2: adding low-carbon intervention as a predictor. The model explained an additional 0% of variance in intention, $\Delta R^2 = 0.00$ ($R^2 = 0.46$), and the model was not a statistically significant improvement over Model 1, $F < 1$.
Model 3: adding demographics, housing-related variables and current low-carbon technology use. The model explained an additional 9% of variance in intention, $\Delta R^2 = 0.09$ ($R^2 = 0.55$), and the model was a statistically significant improvement over Model 2, F (12, 266) = 4.31, $p < 0.001$. Additional significant predictors were ethnicity (higher subjective norm for non-whites), disability (higher for non-disabled), employment (higher for employed) and solar installation (higher with solar generation installed).

3.6.6 Subjective norm – subsample: renters

The main outcome measure was behavioural intention, this time for renters only and separately for England outside Teesside and for Teesside. The analysis of renters' data allowed us to examine variables that are specific to renters: first, the influence of landlord and, second, the behaviour of other residents. As before, three models were analysed.

3.6.6.1 England

Model 1: injunctive/motivation to comply and descriptive beliefs/identification. The model explained 45% of variance in perceived behavioural control, $R^2 = 0.45$, and the model was a statistically significant improvement over using the mean of perceived control as a predictor, F (4, 1211) = 245.10, $p < 0.001$. Positive significant predictors were family influence and family behaviour as well as landlord's influence and residents' behaviour.
Model 2: adding low-carbon intervention as a predictor. The model explained an additional 0% of variance in intention, $\Delta R^2 = 0.00$ ($R^2 = 0.45$), and the model was not a statistically significant improvement over Model 1, $F < 1$.
Model 3: adding demographics, housing-related variables and current low-carbon technology use. The model explained an additional 2% of variance in intention, $\Delta R^2 = 0.02$ ($R^2 = 0.47$), and the model was a statistically significant improvement over Model 2, F (12, 3514) = 8.67, $p < 0.001$. Age was an additional significant negative predictor (lower subjective norm with increasing age). Solar installation was an additional significant predictor (higher with solar generation installed).

3.6.6.2 Teesside

The analyses for the Teesside did not show significant results for the influence of landlord and other residents' behaviour.

3.6.7 Perceived behavioural control – full sample

3.6.7.1 England

Model 1: control beliefs/power of control factors. The model explained 23% of variance in perceived behavioural control, $R^2 = 0.23$, and the model was a statistically significant improvement over using the mean of perceived control as a predictor, F (8, 3521) = 128.30, $p < 0.001$. Positive significant predictors were government support, low-carbon technology accessibility, low-carbon technology affordability and unappealingness of heat pump appearance on the outside of the house, the latter presumably because of suppression. Negative predictors were insufficient space, disruption, difficulty of repair and insufficient knowledge.
Model 2: adding low-carbon intervention as a predictor. The model explained an additional 0.2% of variance in intention, $\Delta R^2 = 0.002$ ($R^2 = 0.23$), and the model was a statistically significant improvement over Model 1, F (1, 3520) = 18.04, $p < 0.001$. Perceived behavioural control was higher for decarbonisation in a new-build rather than a retrofit home.
Model 3: adding demographics, housing-related variables and current low-carbon technology use. The model explained an additional 7% of variance in intention, $\Delta R^2 = 0.07$ ($R^2 = 0.30$), and the model was a statistically significant improvement over Model 2, F (12, 3508) = 30.51, $p < 0.001$. Age was an additional significant negative predictor (lower intention with increasing age) and bedrooms was a significant positive predictor (higher with more bedrooms). Additional significant predictors were homeownership (owners higher than others), gender (men higher than women), ethnicity (non-white higher than white), disability (non-disabled higher than disabled), work status (employed higher than others), home type ([demi-]detached higher than other), current solar use

(user higher than non-user), having additional insulation installed and having a smart meter installed (both higher with installation).

3.6.7.2 Teesside

Model 1: control beliefs/power of control factors. The model explained 25% of variance in perceived behavioural control, $R^2 = 0.25$, and the model was a statistically significant improvement over using the mean of perceived control as a predictor, F (8, 273) = 11.61, $p < 0.001$. Affordability of operating low-carbon was a significant positive predictor. Disruption was a significant negative predictor.
Model 2: adding low-carbon intervention as a predictor. The model explained an additional 0% of variance in intention, $\Delta R^2 = 0.00$ ($R^2 = 0.25$), and the model was not a statistically significant improvement over Model 1, $F < 1$.
Model 3: adding demographics, housing-related variables and current low-carbon technology use. The model explained an additional 11% of variance in intention, $\Delta R^2 = 0.11$ ($R^2 = 0.36$), and the model was a statistically significant improvement over Model 2, F (12, 260) = 3.50, $p < 0.001$. Age was a significant additional negative predictor (lower intention with increasing age) and number of bedrooms was a significant positive predictor (higher intention with more bedrooms). Further significant predictors were homeownership (homeowners higher than others), gender (women lower than others) and education level (degree/higher degree lower than others), the latter possibly because of suppression.

3.7 Willingness to pay and willingness to accept

Descriptives are presented numerically in Table 3 and graphically in Appendix B.

3.7.1 Descriptive analysis: retrofit or new build of rented home

Among the most striking results was that, in renters, *willingness to pay* for living in a low-carbon home (measured as the size of an increase in rent) was far less (£30 to £60 on average for different region/residential-decarbonisation intervention [new build or retrofit] combinations) than *willingness to accept* not having the collective 8 listed individual elements of low-carbon technology in a low-carbon home (£150 to £290 on average). In fact, on average, willingness to pay was only 20% (5:1 ratio) of willingness to accept summed over the 8 elements. Relative to typical ratios for easily substitutable market goods of approximately 2:1 (Morewedge & Giblin, 2015), this ratio is clearly low.
The mean acceptable increase in monthly rent was similar between new build (£50) and retrofit (£45) in English respondents (about 10% lower). However, for Teesside respondents the acceptable increase was almost twice as large for new build (£60) than for retrofit (£31.5). A common pattern of relatively big differences between new build (higher) and retrofit (lower) for Teesside (on average 42%) compared with England (on average 18%) occurred in the following willingness to accept (WTA) measures and for willingness to pay (WTP):

- Rent reduction for radiator size increase by 20%

- Rent reduction for storage space reduction by 10%
- Rent reduction for not living in a house with additional insulation
- Rent reduction for having an existing energy source rather than a heat pump
- Rent reduction for not having a smart meter
- Rent reduction for not having a battery energy storage system

Rent reduction for not having solar panels
In Teesside respondents, the pattern was different for rent reduction for a reduction in yard/garden space by 1m^2 (new build about 35% lower). In England, WTA for this reduction was slightly (8%) higher new build.
According to our WTA results, for renters the most valued aspect of low-carbon technology was not having bigger radiators. The least valued was a smart meter. Mean WTA over the 8 elements varied between £19 and £36 (average £25) for the different region/residential-decarbonisation intervention (new build or retrofit) combinations. There was considerable variability among the 8 aspects, with standard deviations of 10 to 13 for region/residential-decarbonisation intervention (new build or retrofit) combinations.

3.7.2 Descriptive analysis: purchase of new-build home

First, retrofit, and second, new build were analysed separately. This is because the WTP/WTA survey questions differed between these two decarbonisation interventions: additional retrofit cost of an existing home and additional purchase cost of a new house, respectively.
Once more, a striking result was that, in buyers, willingness to pay for living in a low-carbon home (measured as the size of an increase in in refurbishment costs) was less (just under £30000 for Teesside and England) than willingness to accept not having the collective 8 listed individual elements of low-carbon technology of a low-carbon home (£86000 for Teesside and £56000 for England). In fact, willingness to pay was between 34% (Teesside) and 52% (England) of willingness to accept.
According to the willingness to accept results, for buyers the most valued aspect of low-carbon technology was not having a reduction in storage space. The least valued was a smart meter. Mean WTA over the 8 elements was between £10800 (Teesside) and £7000 (England). There was considerable variability among the 8 aspects, with standard deviations of £8900 (Teesside) and £2500 (England).

3.7.3 Descriptive analysis: retrofit of self-owned/mortgaged home

Perhaps the most striking result was the difference in WTP between new build and retrofit, with WTP for retrofit only 12% (Teesside sub-region) or 16% (collective other English sub-regions) of WTP for new build.
Again, a striking result was that in owners/mortgagers of retrofit homes willingness to pay for living in a low-carbon home (measured as the size of an increase in refurbishment costs) was less (mean of £3600 for Teesside and £4800 for England) than willingness to accept not having the collective 8 listed individual elements of low-carbon technology of a low-carbon home (on average

£4600 for Teesside and £5900 for England). In fact, willingness to pay was between 70% (England) and 78% (Teesside) of willingness to accept.

The mean acceptable increase in retrofit cost of an existing owned/mortgaged home was about 25% higher in England (£4800) than in Teesside (£3600).

According to the willingness to accept results, for owners/mortgagers the most valued aspect of low-carbon technology was solar electricity generation. The least valued was a smart meter. Mean WTA over the 8 elements was between £580 (Teesside) and £860 (England). There was considerable variability among the 8 aspects, with standard deviations of 340 (Teesside) and 400 (England).

Table 3

Willlingness to pay (WTP) and willingness to accept

Panel A: renters

Measure	Version	Region	Owner-ship	Mean	LL	UL	Sum WTA	WTA-WTP	WTA/WTP	Min(WTA)	Max(WTA)
WTA1RentOrBuy	new.build	England	renter	50.69	45.00	58.16	246.51	195.82	4.86	14.61	44.47
WTA2Radiator	new.build	England	renter	44.47	39.07	51.84					
WTA3Storage	new.build	England	renter	41.14	36.37	47.77					
WTA4OutdoorSpace	new.build	England	renter	20.35	17.14	24.93					
WTA5Insulation	new.build	England	renter	26.32	22.00	32.44					
WTA6Heatpump	new.build	England	renter	37.73	33.13	44.69					
WTA7Smartmeter	new.build	England	renter	14.61	11.88	18.52					
WTA8Battery	new.build	England	renter	27.71	24.13	32.82					
WTA9Solar	new.build	England	renter	34.17	29.90	39.62					
WTA1RentOrBuy	retrofit	England	renter	44.62	38.82	52.72	203.16	158.54	4.55	10.59	40.00
WTA2Radiator	retrofit	England	renter	40.00	34.55	47.54					
WTA3Storage	retrofit	England	renter	38.35	33.13	45.74					
WTA4OutdoorSpace	retrofit	England	renter	18.72	15.33	24.37					
WTA5Insulation	retrofit	England	renter	19.11	16.00	24.21					
WTA6Heatpump	retrofit	England	renter	28.35	23.82	35.38					
WTA7Smartmeter	retrofit	England	renter	10.59	8.38	15.62					
WTA8Battery	retrofit	England	renter	21.75	18.66	27.23					
WTA9Solar	retrofit	England	renter	26.29	23.03	31.50					
WTA1RentOrBuy	new.build	Teesside	renter	60.06	40.09	95.28	288.31	228.26	4.80	9.04	50.06
WTA2Radiator	new.build	Teesside	renter	50.06	28.61	95.44					
WTA3Storage	new.build	Teesside	renter	46.85	29.07	88.84					
WTA4OutdoorSpace	new.build	Teesside	renter	9.04	5.48	14.33					
WTA5Insulation	new.build	Teesside	renter	34.98	16.65	79.66					
WTA6Heatpump	new.build	Teesside	renter	46.13	26.46	87.82					
WTA7Smartmeter	new.build	Teesside	renter	27.50	8.33	76.51					
WTA8Battery	new.build	Teesside	renter	33.20	20.26	59.60					
WTA9Solar	new.build	Teesside	renter	40.56	23.91	71.07					
WTA1RentOrBuy	retrofit	Teesside	renter	31.52	21.77	62.18	153.65	122.12	4.87	3.88	34.05
WTA2Radiator	retrofit	Teesside	renter	34.05	23.48	57.63					
WTA3Storage	retrofit	Teesside	renter	32.00	22.62	53.07					
WTA4OutdoorSpace	retrofit	Teesside	renter	12.18	7.31	24.21					
WTA5Insulation	retrofit	Teesside	renter	15.23	9.69	23.15					
WTA6Heatpump	retrofit	Teesside	renter	18.09	13.49	24.60					
WTA7Smartmeter	retrofit	Teesside	renter	3.88	1.67	9.85					
WTA8Battery	retrofit	Teesside	renter	16.22	11.03	23.72					
WTA9Solar	retrofit	Teesside	renter	22.00	15.51	33.64					

Table 3 (continued)
Willlingness to pay (WTP) and willingness to accept
Panel B: owners

Measure	Version	Region	Owner-ship	Mean	LL	UL	Sum WTA	WTA-WTP	WTA/WTP	Min(WTA)	Max(WTA)
WTA1RentOrBuy	new.build	England	owner	29051.18	24593.97	34532.50	55736.12	26684.95	1.92	2782.38	11025.21
WTA2Radiator	new.build	England	owner	9604.16	7493.45	12716.48					
WTA3Storage	new.build	England	owner	11025.21	8703.80	14768.36					
WTA4OutdoorSpace	new.build	England	owner	5770.63	4214.62	8042.36					
WTA5Insulation	new.build	England	owner	5639.01	4058.04	8327.22					
WTA6Heatpump	new.build	England	owner	7299.43	5578.55	9967.82					
WTA7Smartmeter	new.build	England	owner	2782.38	1587.41	5366.21					
WTA8Battery	new.build	England	owner	6238.38	4680.00	8567.81					
WTA9Solar	new.build	England	owner	7376.93	5604.56	10600.45					
WTA1RentOrBuy	retrofit	England	owner	4819.29	4088.58	7065.70	6908.41	2089.13	1.43	191.83	1454.03
WTA2Radiator	retrofit	England	owner	1081.44	929.18	1335.71					
WTA3Storage	retrofit	England	owner	1053.60	904.06	1253.40					
WTA4OutdoorSpace	retrofit	England	owner	649.27	531.76	826.52					
WTA5Insulation	retrofit	England	owner	482.88	396.36	611.45					
WTA6Heatpump	retrofit	England	owner	1087.94	941.39	1271.61					
WTA7Smartmeter	retrofit	England	owner	191.83	145.52	264.46					
WTA8Battery	retrofit	England	owner	907.42	780.92	1077.30					
WTA9Solar	retrofit	England	owner	1454.03	1250.79	1848.12					
WTA1RentOrBuy	new.build	Teesside	owner	29653.99	18571.36	47504.92	86534.89	56880.91	2.92	2694.88	28916.49
WTA2Radiator	new.build	Teesside	owner	18092.57	6978.90	63703.36					
WTA3Storage	new.build	Teesside	owner	28916.49	11687.71	73645.32					
WTA4OutdoorSpace	new.build	Teesside	owner	5633.23	2598.88	13475.86					
WTA5Insulation	new.build	Teesside	owner	8652.43	2582.95	25288.19					
WTA6Heatpump	new.build	Teesside	owner	12724.92	5619.04	34261.70					
WTA7Smartmeter	new.build	Teesside	owner	2694.88	749.89	10496.94					
WTA8Battery	new.build	Teesside	owner	4240.54	2622.86	9828.87					
WTA9Solar	new.build	Teesside	owner	5579.84	3723.27	10480.93					
WTA1RentOrBuy	retrofit	Teesside	owner	3616.40	2532.57	5396.45	4638.10	1021.70	1.28	114.07	1094.78
WTA2Radiator	retrofit	Teesside	owner	533.36	365.75	793.39					
WTA3Storage	retrofit	Teesside	owner	585.45	415.22	897.95					
WTA4OutdoorSpace	retrofit	Teesside	owner	436.09	284.61	692.32					
WTA5Insulation	retrofit	Teesside	owner	271.00	152.99	462.94					
WTA6Heatpump	retrofit	Teesside	owner	1042.09	623.08	1690.71					
WTA7Smartmeter	retrofit	Teesside	owner	114.07	51.88	293.39					
WTA8Battery	retrofit	Teesside	owner	561.27	359.54	971.80					
WTA9Solar	retrofit	Teesside	owner	1094.78	672.19	1813.49					

3.7.4 Predicting willingness to pay and willingness to accept

Analysis was conducted to predict the eight willingness-to-pay- and willingness-to-accept measures from demographic, housing-related and low-carbon technology use-related model variables. The analysis was conducted separately/by sub-group for renters (new build and retrofit combined, as they were asked the same WTP/WTA questions), owners/mortgaged (new build), and owners/mortgaged (retrofit). This is because the willingness-to-pay- and willingness-to-accept measures differed between these three groups. The analysis by sub-group was conducted on the England data, as these provided large sample sizes. On the Teesside data the analysis was conducted on renters as a sub-group, but not on the other two sub-groups sample sizes were relatively small (< 100).

3.7.4.1 England, renters

Willingness to pay. The model explained 4% of variance in intention, $R^2 = 0.04$, and the model was a statistically significant improvement over using the mean of willingness as a predictor, F (11, 1296) = 5.22, $p < 0.001$. Age was a significant negative predictor (willingness decreasing with age).

Willingness to accept, radiators. The model explained 6% of variance in intention, $R^2 = 0.06$, and the model was a statistically significant improvement over using the mean of willingness as a predictor, F (11, 1296) = 6.93, $p < 0.001$. Age was a significant negative predictor (willingness decreasing with age). Significant other predictors (willingness higher) were non-white ethnicity and having solar generation installed.

Willingness to accept, storage. The model explained 4% of variance in intention, $R^2 = 0.04$, and the model was a statistically significant improvement over using the mean of willingness as a predictor, F (11, 1296) = 5.41, $p < 0.001$. Age was a significant negative predictor (willingness decreasing with age). Other significant predictors (willingness higher) were woman as gender identity, non-white ethnicity, being employed and having solar generation installed.

Willingness to accept, reduction of outdoor space. The model explained 3% of variance in intention, $R^2 = 0.03$, and the model was a statistically significant improvement over using the mean of willingness as a predictor, F (11, 1296) = 4.05, $p < 0.001$. Significant predictors (willingness higher) were woman as gender identity, non-white ethnicity and being employed.

Willingness to accept, additional insulation. The model explained 3% of variance in intention, $R^2 = 0.03$, and the model was a statistically significant improvement over using the mean of willingness as a predictor, F (11, 1296) = 4.11, $p < 0.001$. Significant predictors (willingness higher) were woman as gender identity, non-white ethnicity, being employed and living in a house with additional insulation.

Willingness to accept, heat pump. The model explained 6% of variance in intention, $R^2 = 0.06$, and the model was a statistically significant improvement over using the mean of willingness as a predictor, F (11, 1296) = 7.05, $p < 0.001$. Age was a significant negative predictor (willingness decreasing with age). Other significant predictors (willingness higher) were woman as gender identity, non-white ethnicity and having solar generation installed.

Willingness to accept, smart meter. The model explained 5% of variance in intention, $R^2 = 0.05$, and the model was a statistically significant improvement over using the mean of willingness as a predictor, F (11, 1296) = 6.37, $p < 0.001$. Age was a significant negative predictor (willingness decreasing with age). Other significant predictors (willingness higher) were non-white ethnicity, being employed and not having a smart meter installed.

Willingness to accept, battery. The model explained 2% of variance in intention, $R^2 = 0.02$, and the model was a statistically significant improvement over using the mean of willingness as a predictor, F (11, 1296) = 2.90, $p < 0.001$. Age was a significant negative predictor (willingness decreasing with age). A further significant predictor (willingness higher) was non-white ethnicity.

Willingness to accept, solar. The model explained 4% of variance in intention, $R^2 = 0.04$, and the model was a statistically significant improvement over using the mean of willingness as a predictor, F (11, 1296) = 5.21, $p < 0.001$. Age was a significant negative predictor (willingness decreasing with age). Other significant predictors (willingness higher) were non-white ethnicity and not having solar generation installed.

3.7.4.2 Teesside, renters

Willingness to pay. The model explained 24% of variance in intention, $R^2 = 0.24$, and the model was a statistically significant improvement over using the mean of willingness as a predictor, F (11, 106) = 3.12, $p = 0.001$. Age was a significant negative predictor (willingness decreasing with age). Other significant predictors (willingness higher) were non-white ethnicity and living in a detached or semi-detached home.

Willingness to accept, radiators. The model explained 28% of variance in intention, $R^2 = 0.28$, and the model was a statistically significant improvement over using the mean of willingness as a predictor, F (11, 106) = 3.70, $p < 0.001$. Age was a significant negative predictor as was number of bedrooms (willingness decreasing with age/bedrooms). A further significant predictor (willingness higher) was non-white ethnicity.

Willingness to accept, storage. The model explained 24% of variance in intention, $R^2 = 0.24$, and the model was a statistically significant improvement over using the mean of willingness as a predictor, F (11, 106) = 3.05, $p = 0.001$. Age was a significant negative predictor (willingness decreasing with age). A further significant predictor (willingness higher) was non-white ethnicity.

Willingness to accept, reduction of outdoor space. The model explained 10% of variance in intention, $R^2 = 0.10$, and the model was not a statistically significant improvement over using the mean of willingness as a predictor, F (11, 106) = 4.05, $p = 0.37$.

Willingness to accept, additional insulation. The model explained 28% of variance in intention, $R^2 = 0.28$, and the model was a statistically significant improvement over using the mean of willingness as a predictor, F (11, 106) = 3.68, $p < 0.001$. Age was a significant negative predictor as was number of bedrooms (willingness decreasing with age/bedrooms). A further significant predictor (willingness higher) was non-white ethnicity.

Willingness to accept, heat pump. The model explained 25% of variance in intention, $R^2 = 0.25$, and the model was a statistically significant improvement over using the mean of willingness as a predictor, F (11, 106) = 3.23, $p < 0.001$. Age was a significant negative predictor as was number of bedrooms (willingness decreasing with age/bedrooms. A further significant predictor (willingness higher) was non-white ethnicity.

Willingness to accept, smart meter. The model explained 27% of variance in intention, $R^2 = 0.27$, and the model was a statistically significant improvement over using the mean of willingness as a predictor, F (11, 106) = 3.59, $p < 0.001$. Number of bedrooms was a significant negative predictor (willingness decreasing with bedrooms). A further significant predictor (willingness higher) was non-white ethnicity.

Willingness to accept, battery. The model explained 16% of variance in intention, $R^2 = 0.16$, and the model was a statistically marginally significant improvement over using the mean of willingness as a predictor, F (11, 106) = 1.82, $p = 0.06$. Age was a significant negative predictor (willingness decreasing with age). A further significant predictor (willingness higher) was non-white ethnicity.
Willingness to accept, solar. The model explained 18% of variance in intention, $R^2 = 0.18$, and the model was a statistically significant improvement over using the mean of willingness as a predictor, F (11, 106) = 2.06, $p = 0.03$. Age was a significant negative predictor (willingness decreasing with age). A further significant predictor (willingness higher) was already having solar generation installed, possibly because of suppression.

3.7.4.3 England, owners, new build

Willingness to pay. The model explained 4% of variance in intention, $R^2 = 0.04$, and the model was a statistically significant improvement over using the mean of willingness as a predictor, F (11, 987) = 3.31, $p < 0.001$. Age was a significant negative predictor (willingness decreasing with age).
Willingness to accept, radiators. The model explained 2% of variance in intention, $R^2 = 0.02$, and the model was a statistically significant improvement over using the mean of willingness as a predictor, F (11, 987) = 6.93, $p < 0.001$. Age was a significant negative predictor (willingness decreasing with age). A further significant predictor (willingness lower) was disability.
Willingness to accept, storage. The model explained 2% of variance in intention, $R^2 = 0.02$, and the model was a statistically significant improvement over using the mean of willingness as a predictor, F (11, 987) = 1.87, $p < 0.005$. Age was a significant negative predictor (willingness decreasing with age). A further significant predictor (willingness higher) was not having woman as gender identity.
Willingness to accept, reduction of outdoor space. The model explained 1% of variance in intention, $R^2 = 0.01$, and the model was not a statistically significant improvement over using the mean of willingness as a predictor, F (11, 987) = 1.31, $p = 0.21$.
Willingness to accept, additional insulation. The model explained 1% of variance in intention, $R^2 = 0.01$, and the model was not a statistically significant improvement over using the mean of willingness as a predictor, F (11, 987) = 1.07, $p = 0.38$.
Willingness to accept, heat pump. The model explained 2% of variance in intention, $R^2 = 0.02$, and the model was a statistically significant improvement over using the mean of willingness as a predictor, F (11, 987) = 1.86, $p = 0.04$. Age was a significant negative predictor (willingness decreasing with age). Other significant predictors (willingness higher) were disability and not living in a detached or semi-detached home.
Willingness to accept, smart meter. The model explained 1% of variance in intention, $R^2 = 0.01$, and the model was not a statistically significant improvement over using the mean of willingness as a predictor, F (11, 987) = 1.30, $p = 0.22$.
Willingness to accept, battery. The model explained 1% of variance in intention, $R^2 = 0.01$, and the model was not a statistically significant improvement over using the mean of willingness as a predictor, F (11, 987) = 1.06, $p = 0.39$.

Willingness to accept, solar. The model explained 2% of variance in intention, $R^2 = 0.02$, and the model was not a statistically significant improvement over using the mean of willingness as a predictor, F (11, 987) = 1.46, $p = 0.14$.

3.7.4.4 England owners, retrofit

Willingness to pay. The model explained 3% of variance in intention, $R^2 = 0.03$, and the model was a statistically significant improvement over using the mean of willingness as a predictor, F (11, 952) = 3.63, $p < 0.001$. Age was a significant positive predictor (willingness increasing with age). Other significant predictors (willingness higher) were non-white ethnicity and living in a detached or semi-detached house.

Willingness to accept, radiators. The model explained 1% of variance in intention, $R^2 = 0.01$, and the model was not a statistically significant improvement over using the mean of willingness as a predictor, $F < 1$.

Willingness to accept, storage. The model explained 2% of variance in intention, $R^2 = 0.02$, and the model was not a statistically significant improvement over using the mean of willingness as a predictor, F (11, 952) = 1.41, $p = 0.16$.

Willingness to accept, reduction of outdoor space. The model explained 1% of variance in intention, $R^2 = 0.01$, and the model was not a statistically significant improvement over using the mean of willingness as a predictor, F (11, 952) = 1.28, $p = 0.23$.

Willingness to accept, additional insulation. The model explained 3% of variance in intention, $R^2 = 0.03$, and the model was a statistically significant improvement over using the mean of willingness as a predictor, F (11, 952) = 2.65, $p = 0.002$. Significant predictors (willingness higher) were non-white ethnicity and not having insulation installed currently.

Willingness to accept, heat pump. The model explained 1% of variance in intention, $R^2 = 0.01$, and the model was not a statistically significant improvement over using the mean of willingness as a predictor, F (11, 952) = 1.23, $p = 0.26$.

Willingness to accept, smart meter. The model explained 3% of variance in intention, $R^2 = 0.03$, and the model was a statistically significant improvement over using the mean of willingness as a predictor, F (11, 952) = 2.31, $p = 0.009$. A significant predictor (willingness higher) was not already having a smart meter installed.

Willingness to accept, battery. The model explained 2% of variance in intention, $R^2 = 0.02$, and the model was not a statistically significant improvement over using the mean of willingness as a predictor, F (11, 952) = 1.52, $p = 0.12$.

Willingness to accept, solar. The model explained 2% of variance in intention, $R^2 = 0.02$, and the model was a statistically significant improvement over using the mean of willingness as a predictor, F (11, 952) = 1.99, $p = 0.03$. Significant predictors (willingness higher) living in a detached or semi-detached home and not having solar generation installed currently.

3.8 Predictors of current use of low-carbon technologies

3.8.1 Descriptive analysis

Descriptives for current use of low-carbon technologies are presented in Figure 6. The most common types of low-carbon technology were smart meter and additional indoor insulation (both over 50%). Solar generation (about 15 %) and battery energy storage (less than 10%) were less common. Because of its low frequency battery storage was not analysed further with inferential statistics.

3.8.2 England

Logistic regression analysis was conducted to identify predictors of the current use of low-carbon technologies among demographics, housing-related variables and other current low-carbon technology use-related model variables.

3.8.2.1 Solar electricity generation

The model explained 4% of variance in intention, $RL^2 = 0.04$, and the model was a statistically significant improvement over a model without predictors, chi square (12) = 106.88, $p < 0.001$. Age was a significant negative predictor (proportion of solar installation decreasing with age). Bedrooms was a significant positive predictor (proportion of solar installation increasing with bedrooms). Other significant predictors (higher proportion of solar installation) were gender identity not being woman, non-white ethnicity, disability, and living in a detached or semi-detached house and having additional home insulation.

3.8.2.2 Insulation

The model explained 4% of variance in intention, $RL^2 = 0.04$, and the model was not a statistically significant improvement over a model without predictors, chi square (12) = 166.63, $p < 0.001$. Intervention was a significant predictor, with a lower proportion of additional insulation in the group that was presented with a retrofit scenario. This is important, as the results for the other predictors have been controlled for the predictor intervention. Positive predictors were age and number of bedrooms. Other significant predictors (higher proportion of additional home insulation) were living in a detached or semi-detached house, having solar generation installed and not having a smart meter installed.

3.8.2.3 Smart meter

The model explained 2% of variance in intention, $RL^2 = 0.02$, and the model was a statistically significant improvement over a model without predictors, chi square (12) = 85.43, $p < 0.001$. Significant predictors (higher proportion of smart-meter installed) were being a homeowner, being employed, living in a detached or semi-detached home, and not having additional home insulation installed.

3.8.3 Teesside

3.8.3.1 Solar electricity generation, Teesside

The model explained 9% of variance in intention, $RL^2 = 0.09$, and the model was approximating a statistically significant improvement over a model without predictors, chi square (12) = 20.74, $p = 0.054$. Age was a significant negative predictor (proportion of solar installation decreasing with age). Other significant predictors (higher proportion of solar installation) were identity not being woman and having a smart meter installed.

3.8.3.2 Insulation

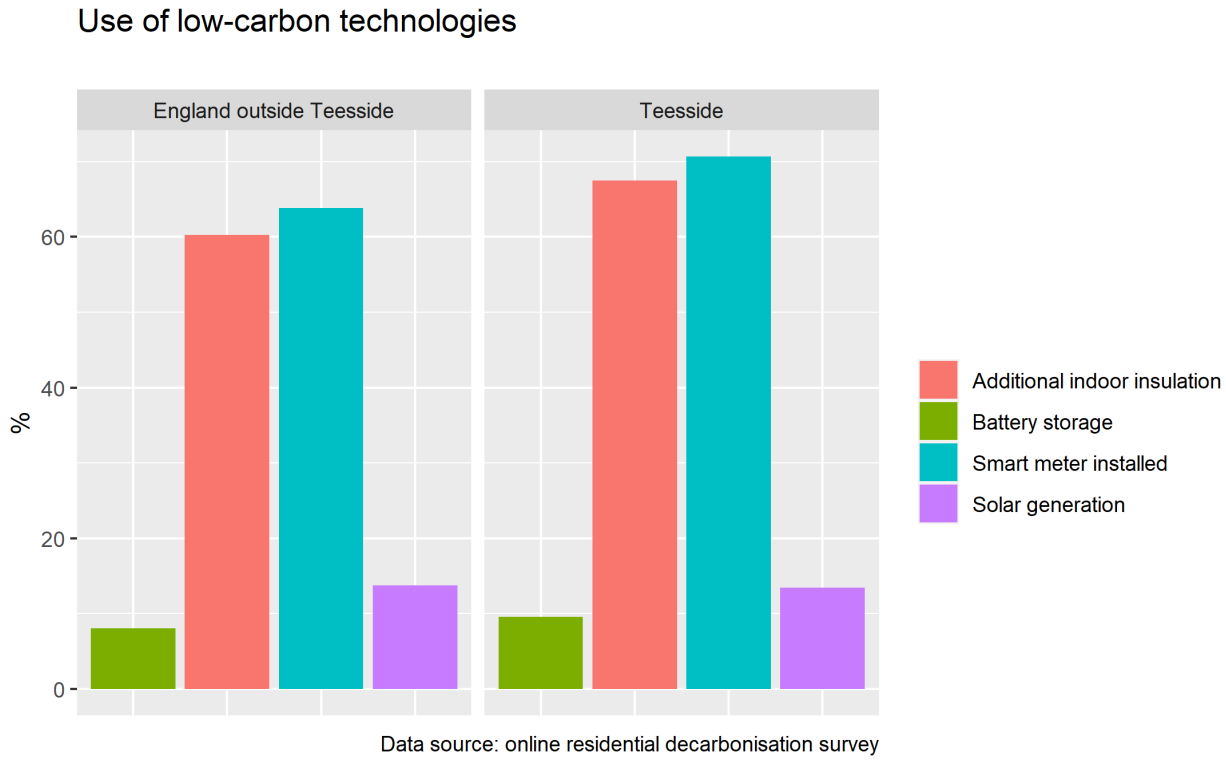
The model explained 4% of variance in intention, $RL^2 = 0.04$, and the model was not a statistically significant improvement over a model without predictors, chi square (12) = 12.56, $p = 0.40$.

3.8.3.3 Smart meter

The model explained 9% of variance in intention, $RL^2 = 0.09$, and the model was a statistically significant improvement over a model without predictors, chi square (12) = 32.26, $p < 0.001$. Significant predictors (higher proportion of smart meters installed) were living in a detached or semi-detached house, not having a disability and having a degree/higher degree or as highest qualification.

Figure 6

Low-carbon technologies



4 Summary and conclusions

4.1 Summary of results

Behaviour-related outcomes. The results across the four main behaviour-related outcomes are mixed, but the pattern is the same for Teesside and England outside Teesside. Attitude towards low-carbon technology was most positive. Perceived behavioural control was middling/high. Behavioural intention was middling. Social influence was middling/low.

Behaviour-related outcome		Teesside	England (outside Teesside)
Behavioural intention	Willingness to change	±	±
Attitude	Feeling about change	+	+
Subjective norm	Social influence on change	-/±	-/±
Perceived behavioural control	Control over change	+/±[a]	+/±[a]

[a]Higher for owners than for renters.

Outcomes of changing to a low-carbon home. Participants provide ratings of their behavioural beliefs: the likelihood that specific outcomes would occur as a result of them changing to a low-carbon home. They also provided ratings of their outcome evaluations: the extent to which they judged specific outcomes as bad or good. The results for behavioural beliefs (about the likelihood of outcome occurring) and outcome evaluations (good/bad) varied across outcomes, from bad unlikely outcomes (for example increase in energy bills) to good likely outcomes (for example health improved).

Likelihood -/evaluation -	Likelihood ±/evaluation -	Likelihood +/evaluation -	Likelihood +/evaluation +
Increase in energy bills	Reduction of indoor living space	Rent increase	Reduction in energy bills
Reduced availability of hot water and electricity			Health improved
			Well-being improved
			Environment improved
			Others encouraged
			Reliable energy supply
			Feeling virtuous
			Feeling secure

Social influence. Participants rated significant others' (for example family members') social expectations of them changing to a low-carbon home. Participants also rated their motivation to comply with these others' expectations. Furthermore, participants rated significant others' (for example family members') social behaviour in terms of these others changing to a low-carbon home. Participants also rated their identification with these significant others. The results for motivation to comply/social expectations and identification/social behaviour varied across sources of influence. For example, those participants believed that family and friends wanted them to change to a low-carbon home, but had not themselves changed to a low-carbon home.

Motivation to comply -/±/ social expectation +	Motivation to comply ±/social expectation ±/+	Identification -/±/social behaviour -
Family/friends	Landlord/housing association	Family/friends
		Fellow residents

Control. Participants rated the strength of control beliefs: the likelihood that specific control factors would occur that would facilitate or hinder them in changing to a low-carbon home. They also rated the power of control factors: the strength of specific facilitators or barriers to them making the change to a low-carbon home. Results for strength of control belief and power varied across control factors, from high likelihood and power (for example, accessibility of low-carbon technologies) to middling likelihood and power (for example insufficient knowledge).

Likelihood ±/power +	Likelihood +/power +	Likelihood ±/power +	Likelihood ±/power ±	Likelihood +/±/power -/±
Government support	Affordability	Insufficient space	Disruption	Heat pump visually unappealing
	Accessibility	Difficulty of repair	Insufficient knowledge	

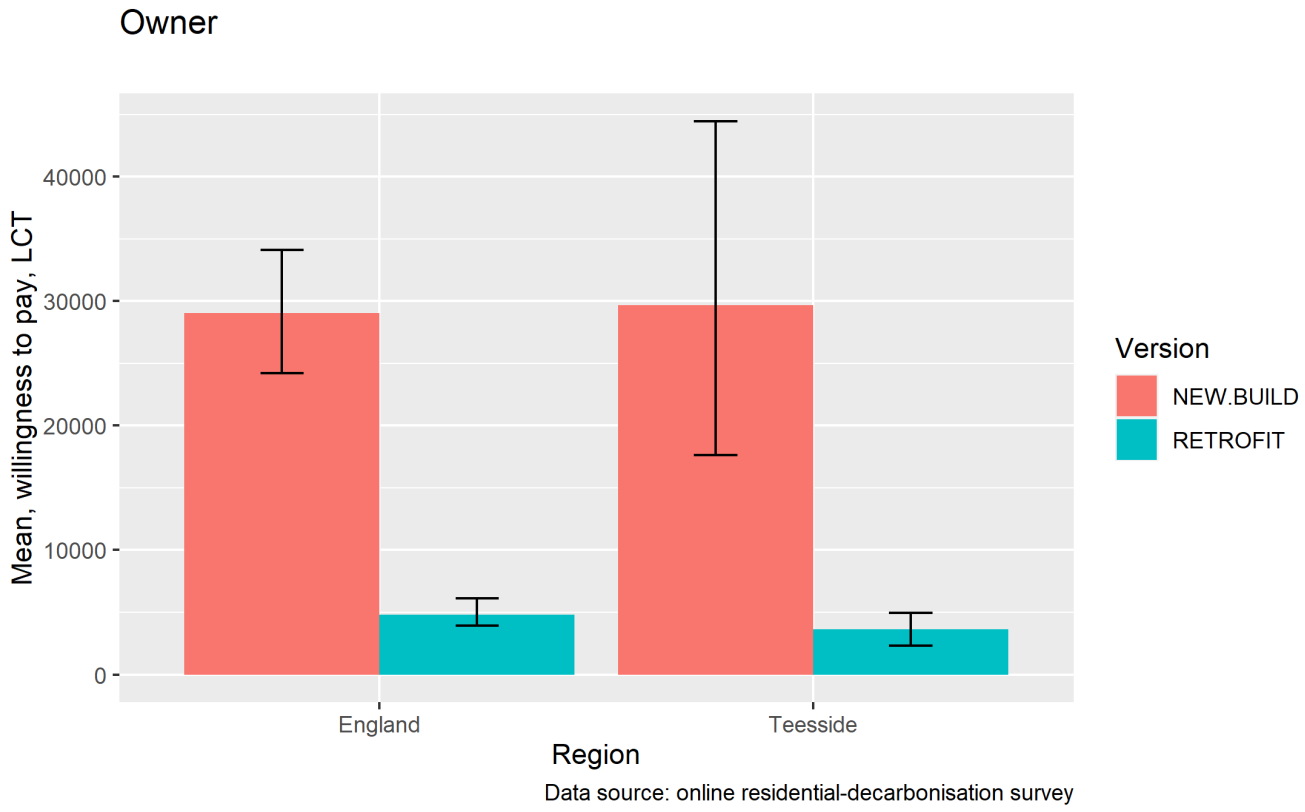
Predictors of outcome variables. For each of the main outcomes, specific statistically significant positive (+) and negative (-) predictors were identified.

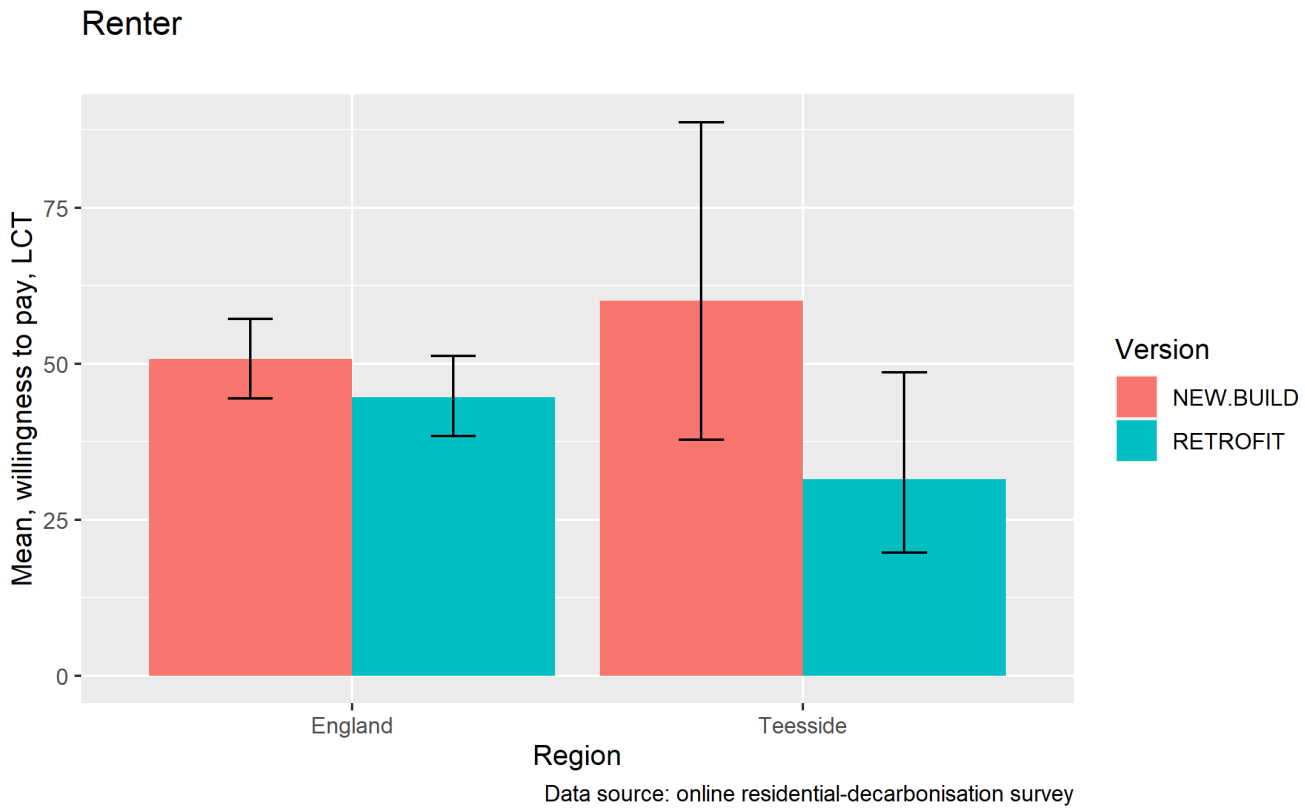
Outcome	Behavioural intention /willingness to change	Attitude /feeling about change	Subjective norm /social influence on change	Perceived behaviour control /control over change
Predictors	Attitude +	Reduced energy bills +	Family social expectation +	Government support +
	Subjective norm +	Improved health +	Family behaviour +	Accessibility of LCT +
	Perceived behavioural control +	Improved well-being +	Non-white ethnicity +	Affordability of LCT +
		Environmental benefit +	Solar installed +	Insufficient space -
		Encouragement of others +	Additional insulation +	Disruption -
		Reliability/energy supply +	Smart meter installed +	Difficulty of repair -
		Feeling virtuous +	Disability -	Insufficient knowledge -
		Feeling secure +	Employment +	New build +
		New build +	Landlord's expectation +	Age -
		Education +	Residents' behaviour +	Woman -
		Smart meter installed +		Non-white ethnicity +
				Disability -
				Employment +
				(Semi-)detached home
				Solar installation +
				Additional insulation +
				Smart-meter installation +

Note. LCT: low-carbon technologies.

Willingness to pay/accept. As the next graph show, willingness to pay by owners for new build was higher (mean just under £30000) than for retrofit (mean below £5000). This may have been because the survey asked either about the additional cost to buy a home with low-carbon technologies installed (new build) or about the additional cost for upgrading their existing home with low-carbon technologies (retrofit). As the next graph shows, willingness to pay (mean around £50) by renters (in terms of rent increase) was, again, higher for a new-build home than for a retrofit home.

The value that respondents placed on low-carbon technologies was lower when measured as willing to pay (WTP) for the whole package of low-carbon technologies than when measured as willingness to accept (WTA). The sum of individual aspects of low-carbon technologies. WTP was 20% of WTA for renters, 34% to 52% for owners/retrofit and 70% to 78% for owners/new build.





Predictors of willingness to pay/willingness to accept. The most consistent predictors of willingness to pay and willingness to accept were non-white ethnicity (higher willingness) and age (willingness decreasing with increasing age). Furthermore, willingness to accept for solar generation was lower for those already having solar generation installed. Similarly, willingness for smart-meter installation was lower for those already have a smart meter installed. Therefore, presumably from their experience with these technologies, these users had developed a more realistic estimate.

	Willingness to pay	Willingness to accept		
Outcome		Larger radiators	Reduced storage	Reduced outdoor space
Predictors	Non-white ethnicity + Age - (semi-) detached home +	Non-white ethnicity + Age - Solar installed + Bedrooms - Disability -	Non-white ethnicity + Age - Solar installed +	Non-white ethnicity + Employment + Woman + Additional insulation +

Outcome	Willingness to accept				
	Additional insulation	Heat pump	Smart meter	Battery energy storage	Solar generation
Predictors	Non-white ethnicity + Age - Bedrooms - Employment + Woman + Additional insulation installed -	Non-white ethnicity + Age - Solar installed + Bedrooms - Woman +	Non-white ethnicity + Age - Bedrooms - Employment + Smart meter installed -	Non-white ethnicity + Age -	Non-white ethnicity + Age - Solar installed - (semi-) detached home +

Current use of low-carbon technologies. The diffusion of additional insulation and smart meters was relatively high (60% to 70%). The diffusion of solar generation (11% to 14%) and battery energy storage was relatively low (7%). The order of these rates of the actual use of low-carbon technologies reflects the order in the fabric-first approach: insulation and smart metering, followed by solar photovoltaic generation and battery energy storage. This exposes or confirms the scale of change that will be needed to achieve existing government net zero targets.

Predictors of current use of low-carbon technologies. Predictors of the current use of low-carbon technologies varied considerably between the technologies. The most consistent non-technology predictor was number of bedrooms, a potential indicator of affluence.

Outcome	Smart-meter installation	Additional home insulation	Solar installation
Predictor	Homeowner + Employment + (Semi-)detached home + Additional home insulation - Disability - Education +	Age + Bedrooms + (Semi-)detached home + Solar installation + Smart-meter installation +	Age - Bedrooms + Woman - Non-white ethnicity + Disability - (Semi-)detached home + Additional home insulation + Smart-meter installation +

4.2 Limitations

Region of England suffered from an extreme split. Therefore a direct statistical comparison between the Teesside sub-region and the collective other English sub-regions was not undertaken. However, the pattern of results were compared between the sub-region and the collective.

The analysis of ethnicity suffered from an extreme split. Therefore, the true association between ethnicity and other variables may be underestimated.

4.3 Conclusions

4.3.1 General recommendations

Where appropriate and with a basis in reality, interventions should aim to change evaluations of the outcomes of changing to a low-carbon home from low or middling to high.

Where appropriate, interventions should aim to change beliefs (likelihoods) of positive evaluations from middling or low to high.

Where appropriate, interventions should aim to change beliefs (likelihoods) of negative evaluations from high to low.

Where appropriate, interventions should prioritise addressing significant predictors of behavioural intention, attitude, social influence, perceived behavioural control, willingness to pay/accept and current use of low-carbon technologies.

The subjective relative importance of individual low-carbon technologies is a potentially important concept in the transition to a low-carbon home, as will now be explained. From willingness to accept, the subjective relative importance SRI can be calculated as a percentage of each (consequence of) low-carbon technology (LCT).[1]

Application 1: compare SRI with actual percentage potential relative contribution (PRI) of each LCT to energy saving to quantify mismatch.

Application 2: design customer educational communication to reduce (substantial) mismatches.

Application 3: design marketing communication to customers, emphasising the importance of LCT elements/consequences with mismatch biased against PRI to increase LCT acceptance and de-emphasising LCT elements/consequences with mismatch biased in favour of PRI.

Implications should be considered of currently used LCTs, by designing communication for education to target little-used and therefore presumably less familiar LCTs (for example, heat pump) and designing marketing communication emphasising more commonly used therefore presumably (more) familiar LCTs (for example, solar generation and additional insulation).

[1] $SRI(LCT_j) = 100 * \text{mean value}(WTA_j)/\text{total value}(WTA_{i,\, i \neq j})$

4.3.2 Specific recommendations

In terms of main behaviour-related outcomes, it would be important to increase intention to change by increasing social influence and perceived behavioural control. This is because intention was middling (neither high nor low), while social influence was middling/low and perceived behavioural control was middling/high. Attitude was highly positive and therefore would not require the attention that the other outcomes do.

In turn, social influence can potentially be enhanced by engaging with those of white ethnicity, those without solar generation installed, those without additional insulation, those without a smart meter installed, disabled people and unemployed people. Efforts to enhance social influence through family member's expectations and behaviour, landlords' expectations and fellows residents' may be challenging, as motivation to comply and identification were low or middling.

Also in turn, perceived behavioural control can potentially be enhanced by emphasising the following factors in communication: government support for installing low-carbon technologies, accessibility of low-carbon technologies and their affordability, by avoiding or minimising disruption during installation, identifying and implementing solutions to combat the potential problem of insufficient space to install low-carbon technologies, ensuring sufficient supply of repair, ensuring residents of having sufficient knowledge to operate low-carbon technologies. Perceived behavioural control can potentially be further enhanced by engaging older people, less affluent people, women, people of white ethnicity, disabled people, unemployed people, those without solar generation or a smart meter installed and those currently without additional home insulation.

In addition, attitude can potentially be enhanced by emphasising the following factors in communication: reduced energy bills, improved health, improved well-being, environmental benefit, encouragement of others, reliability/energy supply, feeling virtuous by taking part in the energy transition and feeling secure. Attitude may be further enhanced by engaging with those with lower education level, those without a smart meter installed and those who will be eligible for retrofit installation of low-carbon technologies.

Given the identified potential challenge to increase social influence, given the relatively high level of attitude towards changing to a low carbon home and given the identified potential for enhancing perceived behavioural control, enhancing residents' perceived behavioural control may be especially useful to consider in order to increase intention.

From the perspective of using willingness to pay for/willingness to accept low-carbon technologies, acceptance can potentially be enhanced especially by engaging with the white population segment and older people.

From the perspective of existing use of low-carbon technologies, acceptance can potentially be enhanced as follows. In efforts to increase acceptance of smart-meter installation most important would be to engage less affluent and educated people as well as disabled people; to increase additional home insulation most important would be to engage less affluent people and those without solar- and smart-meter installation; to increase solar installation most important would be to engage older people, white people, disabled people, less affluent people and those without additional home insulation or a smart meter installed.

Acknowledgement

The author is grateful to UK Community Renewal Fund for supporting the research.

References

Ajzen, I. (2020). The theory of planned behavior: frequently asked questions. *Human Behavior and Emerging Technologies*, *2*(4), 314-324.
Arbona, C., Fan, W., Phang, A., Olvera, N., & Dios, M. (2021). Intolerance of uncertainty, anxiety, and career indecision: A mediation model. *Journal of Career Assessment*, *29*(4), 699-716.
Morewedge, C. K., & Giblin, C. E. (2015). Explanations of the endowment effect: an integrative review. *Trends in cognitive sciences*, *19*(6), 339-348.

Part 2. Comparative survey of Tees Valley residents' and national responses to low-carbon technologies in the home – Appendix A – online survey, new build

Paul van Schaik
Centre for Applied Psychological Science
Teesside University

low-carbon home survey N22.09.06L

Information about the study

Welcome to the study!

Please read the following information carefully.

Hello, we are Paul van Schaik, Professor of Psychology, and Matthew Cotton, Professor of Public Policy, both in the School of Social Sciences, Humanities and Law at Teesside University. We are undertaking a research project and would like to invite you to take part. Before you decide if you want to please read the following information and discuss it with others if you wish.

WHAT IS THE PURPOSE OF THE STUDY?

The aim of this specific study is to analyse Tees Valley citizens' beliefs, experience, knowledge and skills regarding the Tees Valley's transition towards low-carbon energy in the home.

WHY AM I BEING INVITED TO TAKE PART?

You have been invited because you are an adult citizen of the Tees Valley. Unfortunately, if you are not are living in the Tees Valley then you cannot take part.

DO I HAVE TO TAKE PART?

No, it's up to you if you want to, or not.

WHAT WOULD I BE ASKED TO DO IF I CHOSE TO TAKE PART?

You will be asked to answer a questionnaire regarding issues of low-carbon technologies in the home. This will take about 20 minutes to complete. It will ask you questions about your beliefs, experience, and knowledge of low-carbon technologies for heating, lighting and hot water in the home.

WHAT ARE THE POSSIBLE BENEFITS TO TAKING PART?

There are no direct benefits for those who choose to take part, apart from learning more

about low-carbon homes and about people's responses to low-carbon homes. However, the research team plan to share a summary of the finding with participants.

WHAT ARE THE POSSIBLE DISADVANTAGES, OR RISKS, OF TAKING PART?

It is expected that participating in this project will not cause any significant stress or emotional discomfort. This project and questionnaire have been reviewed by the Teesside University ethics committee.

If after taking part, you feel you are affected by the study you may want to consider support offered by the following organisation.

Mind: https://www.mind.org.uk/

WHAT WOULD HAPPEN TO THE ANSWERS THAT I GIVE?

Your consent response and all your other responses will be stored on a university password-protected server for five years and then destroyed.

We collect some personal data including special category data obtained for the purposes of this research project which is processed lawfully in the necessary performance of scientific or historical research or for statistical purposes carried out in the public interest. Processing of personal data including special category data is proportionate to the aims pursued, respects the essence of data protection and provides suitable and specific measures to safeguard the rights and interests of the data subject in full compliance with the General Data Protection Regulation and the Data Protection Act 2018

WHAT WOULD HAPPEN IF I STARTED BUT THEN CHANGED MY MIND?

You may withdraw from the study at any point during the questionnaire, and you can withdraw the information you provide within 28 days of taking part. If you wish to withdraw from the study, please contact either of the lead researchers, Paul van Schaik or Matthew Cotton. After you have given your research identifier all the information you have provided will be removed from the password-protected university server.

WHAT HAPPENS IF THERE ARE ANY PROBLEMS?

If you are unhappy, or there is a problem, please talk to us. If you remain unhappy, or there is an issue which you do not wish to talk to us about please contact either:

Dr Lee Copping, Deputy Chair of School of Social Sciences, Humanities and Law Research Ethics Subcommittee at Teesside University. L.copping@tees.ac.uk

Professor Natasha Vall, Associate Dean for Research School of Social Sciences, Humanities and Law at Teesside University. N.vall@tees.ac.uk

WHO HAS APPROVED THIS STUDY?

This study has been approved by the School of Social Sciences, Humanities and Law, Research Ethics Subcommittee.

Thank you for reading this information sheet and for considering whether to take part in this study. If you have questions after taking part in this study, then please contact us at:

m.cotton@tees.ac.uk; p.van-schaik@tees.ac.uk

Consent to the study

Please read each of the following statements carefully.

Statement 1

I confirm that I have read and understood the information about the study on the previous page. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.

Statement 2

I understand that data collected during the study may be looked at by individuals from Teesside University where it is relevant to my taking part in this research. I give permission for these individuals to have access to these data.

Statement 3

I give consent for anonymous quotes to be used from the collected data in publications produced by Teesside University and its partners in the project.

Statement 4

I confirm that my home, as it is, does not have a heat pump to provide home-heating and hot water.

Please answer:

- ○ I have read and I agree to the statements presented on this page
- ○ I do not agree to the statements presented on this page

Attention

It is important that you **pay attention when answering each question**. There are attentiveness checks in this survey.

About you

Please complete the following details about yourself.

What is your age?

About you (2)

What is your gender identity? (Please select one answer.)

- Woman
- Man
- Transgender
- Non-binary/non-conforming

What is your ethnic group?

- White
- Asian and Asian British
- Black, African, Caribbean or Black British
- Mixed and Multiple ethnic groups
- Other ethnic group

Are your day-to-day activities limited because of a health problem or disability which has lasted, or is expected to last, at least 12 months (include any problems related to old age)?

- Yes, limited a little
- Yes, limited a lot
- No

About you (2a)

If you answered ‘yes’ to the previous question, please indicate your disability. Please choose all that apply.

- [ ] Vision (e.g. due to blindness or partial sight)
- [ ] Hearing (e.g. due to deafness or partial hearing)
- [ ] Mobility, such as difficulty walking short distances, climbing stairs, lifting and carrying objects
- [ ] Learning or concentrating or remembering
- [ ] Mental Health
- [ ] Stamina or breathing difficulty
- [ ] Social or behavioural issues (for example, due to neuro-diverse conditions such as autism, attention deficit disorder or Asperger’s syndrome)
- [ ] Other disability

About you (3)

What is the highest level of education that you have achieved? (Please select one answer.) ✱ *Required*

- O level/GCSE or equivalent
- NVQ or equivalent
- A level or equivalent
- TROCN/Btec Dip
- Degree
- Higher degree
- No qualification
- Other

Please prove you're paying attention. Choose Somewhat agree.

- Strongly disagree
- Disagree
- Somewhat disagree
- Neither agree nor disagree
- Somewhat agree
- Agree
- Strongly agree

What is your situation in relation to work? (Please select one answer.) ✱ *Required*

- Retired
- Employed
- Self-employed

- Student
- Full-time homemaker
- Unemployed/looking for work
- Unfit to work
- Other

Your home

What type of home do you live in?

- ○ Flat, ground floor
- ○ Flat, first floor or higher
- ○ Flat, multi-storey
- ○ Mid-terrace house
- ○ End-terrace house
- ○ Semi-detached house
- ○ Detached house
- ○ Maisonette
- ○ Other

If you selected Other, please specify:

What is the number of bedrooms in your home?

What is your postcode? **Please note**: the postcode is only needed in order for us to determine whether you live in the area(s) that we are looking for to take part in this study. This will not be used for any other purposes or will not be shared elsewhere

Demonstration of a low-carbon home

Please watch and pay attention to the video, showing a low-carbon home.

This is important because after watching the video you will be answering questions that ask you to respond to what has been shown in the video.

Please note that this will not be a test of your abilities.

Please click and view Low Carbon Housing. Then close the video page and return to this page.

When you have viewed the video click 'Next'.

Testimony of living in a low-carbon home

Please read and pay attention to the following quotation from a resident who lives in a low-carbon home.

“Initially I was not comfortable with the air source heat pump, but once someone came round and showed me how to use the controls, I was able to set it to a temperature that suited me. I was also told to leave the system to run constantly which I didn’t think was right, but it must have been because my monthly bills went down from £100 to £60 per month. Now that I know how the systems works and how to control the temperature, I feel happy that this heating system is right. I like how the pump adjusts to the weather so that it’s never too hot or too cold. This has made living with my muscular dystrophy much easier.”

Your home (2)

Tell us about who owns your home.

- ○ Social housing/rented
- ○ Private/rented
- ○ Self-owned/mortgaged
- ○ Live with family or friends
- ○ Other

If you selected Other, please specify:

What if (new-build rented home)

Imagine you are considering your landlord’s or housing association's offer to move into a new low-carbon home, as presented in the video.

How much of an increase in monthly rent would you be willing to accept (in £)? Note that with the use of both solar panels and heat pump, typical savings from a home's yearly cost of heating and hot water are 30% to 40%.

By how much would your monthly rent have to be reduced (in £) ...

... if the radiators were increased in size by 20%?

... if the storage space in the home was reduced by 10% percent?

... if the outdoor unit of the heat pump took up 1 square meter of space from your garden/yard? Please put 0 if your home as it is does not have a garden/yard.

... if your refurbished home did not have additional insulation to reduce heat loss as much as possible?
Note that this insulation typically produce savings of 15% to 25% from a home's cost of heating and hot water.
Please put 0 if your home as it is already has additional insulation.

... if instead of a heat pump for heating and hot water, your refurbished home continued to use your existing system(s) for heating and hot water?
Note that a heat pump for heating and hot water typically produce savings of 20% to 26% from a home's cost of heating and hot water.

... if your refurbished home did not have a smart meter?* Please put 0 if your home as it is already has a smart meter.

*"Smart meters measure how much gas and electricity you're using via a remote connection to your energy supplier. They come with an in-home display screen to help you see how much energy you're using and whether you can reduce your energy consumption."

... if your refurbished home did not have a battery energy storage system for storing electricity from solar panels on the roof? Note that a battery energy storage system typically produces savings of 5% to 15% from a home's cost of heating and hot water. Please put 0 if your home as it is already has a battery energy storage system.

... if your refurbished home did not have solar panels on the roof? Note that with the use of solar panels typical savings from a home's yearly cost of heating and hot water are 15% to 40%. Please put 0 if your home as it is already has a solar panels on the roof.

What if - new-build rented home

Imagine you are renting a home and are considering your landlord’s or housing association's offer to move into a new low-carbon home, as presented in the video.

How much of an increase in monthly rent would you be willing to accept (in £)? Note that with the use of both solar panels and heat pump, typical savings from a home's yearly cost of heating and hot water are 30% to 40%.

By how much would your monthly rent have to be reduced (in £) ...

... if the radiators were increased in size by 20%?

... if the storage space in the home was reduced by 10% percent?

... if the outdoor unit of the heat pump took up 1 square meter of space from your garden/yard? Please put 0 if your home as it is does not have a garden/yard.

... if your refurbished home did not have additional insulation to reduce heat loss as much as possible? Note that this insulation typically produce savings of 15% to 25% from a home's cost of heating and hot water. Please put 0 if your home as it is already has additional insulation.

... if instead of a heat pump for heating and hot water, your refurbished home continued to use your existing system(s) for heating and hot water?
Note that a heat pump for heating and hot water typically produce savings of 20% to 26% from a home's cost of heating and hot water.

... if your refurbished home did not have a smart meter?* Please put 0 if your home as it is already has a smart meter.

*"Smart meters measure how much gas and electricity you're using via a remote connection to your energy supplier. They come with an in-home display screen to help you see how much energy you're using and whether you can reduce your energy consumption."

... if your refurbished home did not have a battery energy storage system for storing

electricity from solar panels on the roof? Note that a battery energy storage system typically produces savings of 5% to 15% from a home's cost of heating and hot water. Please put 0 if your home as it is already has a battery energy storage system.

... if your refurbished home did not have solar panels on the roof? Note that with the use of solar panels typical savings from a home's yearly cost of heating and hot water are 15% to 40%. Please put 0 if your home as it is already has a solar panels on the roof.

What if (new-build self-owned home)

Imagine you are considering buying a new low-carbon home, as presented in the video.

Compared to a new-build home without low-carbon technology, at what additional cost would you be willing to buy a new-build home with low-carbon technology (in £)? Note that with the use of both solar panels and heat pump, typical savings from a home's yearly cost of heating and hot water are 30% to 40%.

By how much would the cost of a new-build home have to be reduced (in £) …

... if the radiators were increased in size by 20%?

... if the storage space in the home was reduced by 10% percent?

... if the outdoor unit of the heat pump took up 1 square meter of space from your garden/yard? Please put 0 if your home as it is does not have a garden/yard.

... if your refurbished home did not have additional insulation to reduce heat loss as much as possible? Note that this insulation typically produce savings of 15% to 25% from a home's cost of heating and hot water. Please put 0 if your home as it is already has additional insulation.

... if instead of a heat pump for heating and hot water, your refurbished home continued to use your existing system(s) for heating and hot water? Note that a heat pump for heating and hot water typically produce savings of 20% to 26% from a home's cost of heating and hot water.

... if your refurbished home did not have a smart meter?* Please put 0 if your home as it is already has a smart meter.

*"Smart meters measure how much gas and electricity you're using via a remote connection to your energy supplier. They come with an in-home display screen to help you see how much energy you're using and whether you can reduce your energy consumption."

... if your refurbished home did not have a battery energy storage system for storing electricity from solar panels on the roof? Note that a battery energy storage system typically produces savings of 5% to 15% from a home's cost of heating and hot water. Please put 0 if your home as it is already has a battery energy storage system.

... if your refurbished home did not have solar panels on the roof? Note that with the use of solar panels typical savings from a home’s yearly cost of heating and hot water are 15% to 40%. Please put 0 if your home as it is already has a solar panels on the roof.

Low-carbon technologies and instructions for answering following questions

Please state the low-carbon technologies in your home (tick all that apply).

- ☐ Solar panels on the roof
- ☐ Battery/Battery energy storage system
- ☐ Efficient thermal insulation solutions (such as wall-, floor-, roof insulation and double glazing) to stop heat loss from your home
- ☐ Smart meter

When answering the following questions please choose one of the presented answers. For example, in some of the questions, the end-point answers are 1 (strongly disagree) and 7 (strongly agree). In-between values (2, 3, 4, 5 and 6) then indicate a degree of (dis)agreement between these two end-points.

Please note that where a low-carbon home is mentioned in the following questions, then think about the low-carbon home that you have seen in the video.

Intention

I intend to live in a low-carbon home and use low-carbon technologies within the next 10 years.

- 1 Definitely do
- 2
- 3
- 4
- 5
- 6
- 7 Definitely do not

I am willing to live in a low-carbon home and use low-carbon technologies within the next 10 years.

- 1 Agree
- 2
- 3
- 4
- 5
- 6
- 7 Disagree

I want to live in a low-carbon home and use low-carbon technologies within the next 10 years.

- 1 Agree
- 2

- 3
- 4
- 5
- 6
- 7 Disagree

I am likely to live in a low-carbon home and use low-carbon technologies within the next 10 years.

- 1 Disagree
- 2
- 3
- 4
- 5
- 6
- 7 Agree

I have decided to live in a low-carbon home and use low-carbon technologies within the next 10 years.

- 1 Disagree
- 2
- 3
- 4
- 5
- 6
- 7 Agree

I am planning to live in a low-carbon home and use low-carbon technologies within the next 10 years.

- 1 Disagree
- 2
- 3
- 4
- 5
- 6
- 7 Agree

Attitude

My living in a low-carbon home and using low-carbon technologies within the next 10 years would be

- 1 Bad
- 2
- 3
- 4
- 5
- 6
- 7 Good

My living in a low-carbon home and using low-carbon technologies within the next 10 years would be

- 1 Pleasant
- 2
- 3
- 4
- 5
- 6
- 7 Unpleasant

My living in a low-carbon home and using low-carbon technologies within the next 10 years would be

- 1 Harmful
- 2

- 3
- 4
- 5
- 6
- 7 Beneficial

My living in a low-carbon home and using low-carbon technologies within the next 10 years would be

- 1 Interesting
- 2
- 3
- 4
- 5
- 6
- 7 Boring

My living in a low-carbon home and using low-carbon technologies within the next 10 years would be

- 1 Foolish
- 2
- 3
- 4
- 5
- 6
- 7 Wise

My living in a low-carbon home and using low-carbon technologies within the next 10 years would be

- 1 Relaxing
- 2
- 3
- 4
- 5
- 6
- 7 Unrelaxing

My living in a low-carbon home and using low-carbon technologies within the next 10 years would be

- 1 Useful
- 2
- 3
- 4
- 5
- 6
- 7 Useless

My living in a low-carbon home and using low-carbon technologies within the next 10 years would be

- 1 Enjoyable
- 2
- 3
- 4

- 5
- 6
- 7 Unenjoyable

Other people in general in relation to low-carbon homes

Most people who are important to me approve of my living in a low-carbon home and using low-carbon technologies within the next 10 years.

- 1 Agree
- 2
- 3
- 4
- 5
- 6
- 7 Disagree

The people in my life whose opinions I value would approve of my living in a low-carbon home and using low-carbon technologies within the next 10 years.

- 1 Agree
- 2
- 3
- 4
- 5
- 6
- 7 Disagree

It is expected of me that I live in a low-carbon home and use low-carbon technologies within the next 10 years.

- 1 Agree
- 2

- 3
- 4
- 5
- 6
- 7 Disagree

Most people like me live in a low-carbon home and use low-carbon technologies.

- 1 Unlikely
- 2
- 3
- 4
- 5
- 6
- 7 Likely

Prove you're paying attention. Choose Disagree.

- Strongly disagree
- Disagree
- Somewhat disagree
- Neither agree nor disagree
- Somewhat agree
- Agree
- Strongly agree

The people in my life whose opinions I value live in a low-carbon home and use low-

carbon technologies.

- 1 Agree
- 2
- 3
- 4
- 5
- 6
- 7 Disagree

Most people who are important to me live in a low-carbon home and using low-carbon technologies.

- 1 Agree
- 2
- 3
- 4
- 5
- 6
- 7 Disagree

Capacity and control

I am confident that I can live in a low-carbon home and use low-carbon technologies within the next 10 years.

- 1 True
- 2
- 3
- 4
- 5
- 6
- 7 False

My living in a low-carbon home and using low-carbon technologies within the next 10 years is up to me.

- 1 Disagree
- 2
- 3
- 4
- 5
- 6
- 7 Agree

Living in a low-carbon home and using low-carbon technologies within the next 10 years is under my control.

- 1 Disagree
- 2

- 3
- 4
- 5
- 6
- 7 Agree

I have the resources, knowledge, and ability to live in a low-carbon home and using low-carbon technologies within the next 10 years.

- 1 Disagree
- 2
- 3
- 4
- 5
- 6
- 7 Agree

There are few outside events that could prevent me from living in a low-carbon home and using low-carbon technologies within the next 10 years.

- 1 Definitely false
- 2
- 3
- 4
- 5
- 6
- 7 Definitely true

I am capable of living in a low-carbon home and using low-carbon technologies within the next 10 years.

- 1 Definitely false
- 2
- 3
- 4
- 5
- 6
- 7 Definitely true

For me to live in a low-carbon home and using low-carbon technologies within the next 10 years would be

- 1 Completely impossible
- 2
- 3
- 4
- 5
- 6
- 7 Definitely possible

Living in a low-carbon home and using low-carbon technologies within the next 10 years is beyond my personal control

- 1 Definitely false
- 2
- 3
- 4

- 5
- 6
- 7 Definitely true

Possible outcomes of living in a low-carbon home

My living in a low-carbon home and using low-carbon technologies within the next 10 years will result in reducing my energy bills/service charges.

- 1 Likely
- 2
- 3
- 4
- 5
- 6
- 7 Unlikely

Reducing my energy bills/service charges is

- 1 Good
- 2
- 3
- 4
- 5
- 6
- 7 Bad

My living in a low-carbon home and using low-carbon technologies within the next 10 years will result in improved health for myself and my family (for example no or reduced breathing complaints).

- 1 Likely
- 2

- 3
- 4
- 5
- 6
- 7 Unlikely

Improved health for myself and my family (for example no or reduced breathing complaints) is

- 1 Good
- 2
- 3
- 4
- 5
- 6
- 7 Bad

My living in a low-carbon home and using low-carbon technologies within the next 10 years will result in improved wellbeing for myself and my family (for example, pride to live in a low-carbon home).

- 1 Likely
- 2
- 3
- 4
- 5
- 6
- 7 Unlikely

Improved wellbeing for myself and my family (for example, pride to live in a low-carbon home) is

- 1 Good
- 2
- 3
- 4
- 5
- 6
- 7 Bad

My living in a low-carbon home and using low-carbon technologies within the next 10 years will result in protection of the environment through reduced energy use in the home.

- 1 Likely
- 2
- 3
- 4
- 5
- 6
- 7 Unlikely

Protection of the environment through reduced energy use in the home is

- 1 Good
- 2
- 3
- 4

- 5
- 6
- 7 Bad

My living in a low-carbon home and using low-carbon technologies within the next 10 years will encourage other people to switch to living in a low-carbon home.

- 1 Likely
- 2
- 3
- 4
- 5
- 6
- 7 Unlikely

Encouragement for other people to switch to living in a low-carbon home is

- 1 Good
- 2
- 3
- 4
- 5
- 6
- 7 Bad

My living in a low-carbon home and using low-carbon technologies within the next 10 years will give me a reliable source of energy through solar panels.

- 1 Likely
- 2
- 3
- 4
- 5
- 6
- 7 Unlikely

Having a reliable source of energy through solar panels is

- 1 Good
- 2
- 3
- 4
- 5
- 6
- 7 Bad

My living in a low-carbon home and using low-carbon technologies within the next 10 years will make me feel virtuous: living more sustainably and protecting the environment against climate change.

- 1 Likely
- 2
- 3
- 4
- 5
- 6
- 7 Unlikely

Feeling virtuous because of living more sustainably and protecting the environment against climate change is

- 1 Good
- 2
- 3
- 4
- 5
- 6
- 7 Bad

My living in a low-carbon home and using low-carbon technologies within the next 10 years will make me feel secure because of having a reliable source of energy through solar panels.

- 1 Likely
- 2
- 3
- 4
- 5
- 6
- 7 Unlikely

Feeling secure because of having a reliable source of energy through solar panels is

- 1 Good

- 2
- 3
- 4
- 5
- 6
- 7 Bad

My living in a low-carbon home and using low-carbon technologies within the next 10 years will result in increasing my energy bills/service charges.

- 1 Likely
- 2
- 3
- 4
- 5
- 6
- 7 Unlikely

Increasing my energy bills/service charges is

- 1 Good
- 2
- 3
- 4
- 5
- 6
- 7 Bad

My living in a low-carbon home and using low-carbon technologies within the next 10 years will result in consistently reduced availability of hot water and electricity.

- 1 Likely
- 2
- 3
- 4
- 5
- 6
- 7 Unlikely

Consistently reduced availability of hot water and electricity is

- 1 Good
- 2
- 3
- 4
- 5
- 6
- 7 Bad

My living in a low-carbon home and using low-carbon technologies within the next 10 years will result in reduced indoor living space.

- 1 Likely
- 2
- 3
- 4
- 5

- 6
- 7 Unlikely

Reduced indoor living space is

- 1 Good
- 2
- 3
- 4
- 5
- 7 Bad

My living in a low-carbon home and using low-carbon technologies within the next 10 years will result in a rent increase.

- 1 Likely
- 2
- 3
- 4
- 5
- 6
- 7 Unlikely
- 8 I do not rent a home or do not rent from a housing association

A rent increase is

- 1 Good

- 2
- 3
- 4
- 5
- 6
- 7 Bad
- 8 I do not rent a home or do not rent from a housing association

Specific other people in relation to low-carbon homes

When answering the following question please choose one of the presented answers. The end-point answers are 1 (should) and 7 (should not). In-between values (2, 3, 4, 5 and 6) then indicate a degree of belief between these two end-points. To what extent do you believe your friends/family/neighbours think that
you should live in a low-carbon home within the next 10 years.

- 1 I should
- 2
- 3
- 4
- 5
- 6
- 7 I should not

When it comes to matters of sustainable living, I want to do what my friends/family/neighbours think I should do.

- 1 Agree
- 2
- 3
- 4
- 5
- 6
- 7 Disagree

When answering the following question please choose one of the presented answers. The end-point answers are 1 (should) and 7 (should not). In-between values (2, 3, 4, 5 and 6) then indicate a degree of belief between these two end-points. To what extent do

you believe your landlord or housing association thinks that you should live in a low-carbon home and using low-carbon technologies within the next 10 years.

- 1 I should
- 2
- 3
- 4
- 5
- 6
- 7 I should not
- 8 I do not rent a home or do not rent from a housing association

When it comes to matters of sustainable living, I want to do what my landlord or housing association thinks I should do.

- 1 Agree
- 2
- 3
- 4
- 5
- 6
- 7 Disagree
- 8 I do not rent a home or do not rent from a housing association

Most of my friends/family/neighbours live in a low-carbon home and used low-carbon technologies.

- 1 False
- 2

- 3
- 4
- 5
- 6
- 7 True

When it comes to matters of sustainable living, how much do you want to be like your friends/family/neighbours?

- 1 Very much
- 2
- 3
- 4
- 5
- 6
- 7 Not at all

Most residents who rent from the same landlord or housing association as I do live in a low-carbon home and use low-carbon technologies.

- 1 False
- 2
- 3
- 4
- 5
- 6
- 7 True
- 8 I do not rent a home or do not rent from a housing association

When it comes to matters of sustainable living, how much do you want to be like residents who rent from the same landlord or housing association as you do ?

- 1 Very much
- 2
- 3
- 4
- 5
- 6
- 7 Not at all
- 8 I do not rent a home or do not rent from a housing association

Specific external factors

I expect that I will receive support from the government or local authority to install low-carbon technology in my home.

- 1 Likely
- 2
- 3
- 4
- 5
- 6
- 7 Unlikely

Support from the government or local authority to install low-carbon technology in my home would enable me to live in a low-carbon home and using low-carbon technologies within the next 10 years.

- 1 Disagree
- 2
- 3
- 4
- 5
- 6
- 7 Agree

I expect that the heat pump controls in my low-carbon technology home will be accessible to manage the system.

- 1 Likely
- 2

- 3
- 4
- 5
- 6
- 7 Unlikely

Accessible heat pump controls in my low-carbon technology home to manage the system would enable me to live in a low-carbon home and using low-carbon technologies within the next 10 years.

- 1 Disagree
- 2
- 3
- 4
- 5
- 6
- 7 Agree

I expect the home energy system in my low-carbon technology home will be affordable to operate.

- 1 Likely
- 2
- 3
- 4
- 5
- 6
- 7 Unlikely

An affordable-to-operate home energy system would enable me to live in a low-carbon home and using low-carbon technologies within the next 10 years.

- 1 Disagree
- 2
- 3
- 4
- 5
- 6
- 7 Agree

I expect that my low-carbon home will have insufficient space for a storage tank.

- 1 Likely
- 2
- 3
- 4
- 5
- 6
- 7 Unlikely

Having insufficient space for a storage tank would prevent me from living in a low-carbon home and using low-carbon technologies within the next 10 years.

- 1 Disagree
- 2
- 3
- 4
- 5

- 6
- 7 Agree

I expect that heat pump installation will cause disruption to living in my low-carbon home.

- 1 Likely
- 2
- 3
- 4
- 5
- 6
- 7 Unlikely

Heat pump installation causing disruption would prevent me from living in a low-carbon home and using low-carbon technologies within the next 10 years.

- 1 Disagree
- 2
- 3
- 4
- 5
- 6
- 7 Agree

I expect that, living in my low-carbon home, it will be difficult to get the heat pump system repaired when necessary.

- 1 Likely
- 2
- 3
- 4
- 5
- 6
- 7 Unlikely

Difficulty in getting the heat pump system repaired when necessary would prevent me from living in a low-carbon home and using low-carbon technologies within the next 10 years.

- 1 Disagree
- 2
- 3
- 4
- 5
- 6
- 7 Agree

Prove you're paying attention. Choose Agree.

- Strongly disagree
- Disagree
- Somewhat disagree
- Neither agree nor disagree
- Somewhat agree
- Agree

- Strongly agree

I expect that I will have insufficient knowledge and skills regarding how to operate my low-carbon home.

- 1 Likely
- 2
- 3
- 4
- 5
- 6
- 7 Unlikely

Having insufficient knowledge and skills regarding how to operate my low-carbon home would prevent me from living in a low-carbon home and using low-carbon technologies within the next 10 years.

- 1 Disagree
- 2
- 3
- 4
- 5
- 6
- 7 Agree

I expect that the heat pump on the outside of my low-carbon home will look unappealing.

- 1 Likely

- 2
- 3
- 4
- 5
- 6
- 7 Unlikely

Poor visual appeal of heat pump on the outside would prevent me from living in a low-carbon home and using low-carbon technologies within the next 10 years.

- 1 Disagree
- 2
- 3
- 4
- 5
- 6
- 7 Agree

End of survey

End of survey - thank you for taking part.

Kindly click here to submit your response.

Key for selection options

3 - What is your age?

- under 18
- 18
- 19
- 20
- 21
- 22
- 23
- 24
- 25
- 26
- 27
- 28
- 29
- 30
- 31
- 32
- 33
- 34
- 35
- 36
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Part 2. Comparative survey of Tees Valley residents' and national responses to low-carbon technologies in the home – Appendix A – online survey, retrofit

Paul van Schaik
Centre for Applied Psychological Science
Teesside University

low-carbon home survey R22.09.06L

Information about the study

Welcome to the study!

Please read the following information carefully.

Hello, we are Paul van Schaik, Professor of Psychology, and Matthew Cotton, Professor of Public Policy, both in the School of Social Sciences, Humanities and Law at Teesside University. We are undertaking a research project and would like to invite you to take part. Before you decide if you want to please read the following information and discuss it with others if you wish.

WHAT IS THE PURPOSE OF THE STUDY?

The aim of this specific study is to analyse Tees Valley citizens' beliefs, experience, knowledge and skills regarding the Tees Valley's transition towards low-carbon energy in the home.

WHY AM I BEING INVITED TO TAKE PART?

You have been invited because you are an adult citizen of the Tees Valley. Unfortunately, if you are not are living in the Tees Valley then you cannot take part.

DO I HAVE TO TAKE PART?

No, it's up to you if you want to, or not.

WHAT WOULD I BE ASKED TO DO IF I CHOSE TO TAKE PART?

You will be asked to answer a questionnaire regarding issues of low-carbon technologies in the home. This will take about 20 minutes to complete. It will ask you questions about your beliefs, experience, and knowledge of low-carbon technologies for heating, lighting and hot water in the home.

WHAT ARE THE POSSIBLE BENEFITS TO TAKING PART?

There are no direct benefits for those who choose to take part, apart from learning more

about low-carbon homes and about people's responses to low-carbon homes. However, the research team plan to share a summary of the finding with participants.

WHAT ARE THE POSSIBLE DISADVANTAGES, OR RISKS, OF TAKING PART?

It is expected that participating in this project will not cause any significant stress or emotional discomfort. This project and questionnaire have been reviewed by the Teesside University ethics committee.

If after taking part, you feel you are affected by the study you may want to consider support offered by the following organisation.

Mind: https://www.mind.org.uk/

WHAT WOULD HAPPEN TO THE ANSWERS THAT I GIVE?

Your consent response and all your other responses will be stored on a university password-protected server for five years and then destroyed.

We collect some personal data including special category data obtained for the purposes of this research project which is processed lawfully in the necessary performance of scientific or historical research or for statistical purposes carried out in the public interest. Processing of personal data including special category data is proportionate to the aims pursued, respects the essence of data protection and provides suitable and specific measures to safeguard the rights and interests of the data subject in full compliance with the General Data Protection Regulation and the Data Protection Act 2018

WHAT WOULD HAPPEN IF I STARTED BUT THEN CHANGED MY MIND?

You may withdraw from the study at any point during the questionnaire, and you can withdraw the information you provide within 28 days of taking part. If you wish to withdraw from the study, please contact either of the lead researchers, Paul van Schaik or Matthew Cotton. After you have given your research identifier all the information you have provided will be removed from the password-protected university server.

WHAT HAPPENS IF THERE ARE ANY PROBLEMS?

If you are unhappy, or there is a problem, please talk to us. If you remain unhappy, or there is an issue which you do not wish to talk to us about please contact either:

Dr Lee Copping, Deputy Chair of School of Social Sciences, Humanities and Law Research Ethics Subcommittee at Teesside University. L.copping@tees.ac.uk

Professor Natasha Vall, Associate Dean for Research School of Social Sciences, Humanities and Law at Teesside University. N.vall@tees.ac.uk

WHO HAS APPROVED THIS STUDY?

This study has been approved by the School of Social Sciences, Humanities and Law, Research Ethics Subcommittee.

Thank you for reading this information sheet and for considering whether to take part in this study. If you have questions after taking part in this study, then please contact us at:

m.cotton@tees.ac.uk; p.van-schaik@tees.ac.uk

Consent to the study

Please read each of the following statements carefully.

Statement 1
I confirm that I have read and understood the information about the study on the previous page. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.

Statement 2
I understand that data collected during the study may be looked at by individuals from Teesside University where it is relevant to my taking part in this research. I give permission for these individuals to have access to these data.

Statement 3
I give consent for anonymous quotes to be used from the collected data in publications produced by Teesside University and its partners in the project.

Statement 4
I confirm that my home, as it is, does not have a heat pump to provide home-heating and hot water.

Please answer:

- ○ I have read and I agree to the statements presented on this page
- ○ I do not agree to the statements presented on this page

Attention

It is important that you **pay attention when answering each question**. There are attentiveness checks in this survey.

About you

Please complete the following details.

What is your age?

About you (2)

What is your gender identity? (Please select one answer.)

- Woman
- Man
- Transgender
- Non-binary/non-conforming

What is your ethnic group?

- White
- Asian and Asian British
- Black, African, Caribbean or Black British
- Mixed and Multiple ethnic groups
- Other ethnic group

Are your day-to-day activities limited because of a health problem or disability which has lasted, or is expected to last, at least 12 months (include any problems related to old age)?

- Yes, limited a little
- Yes, limited a lot
- No

About you (2a)

If you answered ‘yes’ to the previous question, please indicate your disability. Please choose all that apply.

- [ ] Vision (e.g. due to blindness or partial sight)
- [ ] Hearing (e.g. due to deafness or partial hearing)
- [ ] Mobility, such as difficulty walking short distances, climbing stairs, lifting and carrying objects
- [ ] Learning or concentrating or remembering
- [ ] Mental Health
- [ ] Stamina or breathing difficulty
- [ ] Social or behavioural issues (for example, due to neuro-diverse conditions such as autism, attention deficit disorder or Asperger’s syndrome)
- [ ] Other disability

About you (3)

What is the highest level of education that you have achieved? (Please select one answer.) ✱ *Required*

- O level/GCSE or equivalent
- NVQ or equivalent
- A level or equivalent
- TROCN/Btec Dip
- Degree
- Higher degree
- No qualification
- Other

Please prove you're paying attention. Choose Somewhat agree.

- Strongly disagree
- Disagree
- Somewhat disagree
- Neither agree nor disagree
- Somewhat agree
- Agree
- Strongly agree

What is your situation in relation to work? (Please select one answer.) ✱ *Required*

- Retired
- Employed
- Self-employed

- Student
- Full-time homemaker
- Unemployed/looking for work
- Unfit to work
- Other

Your home

What type of home do you live in?

- ○ Flat, ground floor
- ○ Flat, first floor or higher
- ○ Flat, multi-storey
- ○ Mid-terrace house
- ○ End-terrace house
- ○ Semi-detached house
- ○ Detached house
- ○ Maisonette
- ○ Other

If you selected Other, please specify:

What is the number of bedrooms in your home?

What is your postcode? **Please note**: the postcode is only needed in order for us to determine whether you live in the area(s) that we are looking for to take part in this study. This will not be used for any other purposes or will not be shared elsewhere

Demonstration of a low-carbon home

Please watch and pay attention to the video, showing a low-carbon home.

This is important because after watching the video you will be answering questions that ask you to respond to what has been shown in the video.

Please note that this will not be a test of your abilities.

Please click and view Low Carbon Housing. Then close the video page and return to this page.

When you have viewed the video click 'Next'.

Testimony of living in a low-carbon home

Please read and pay attention to the following quotation from a resident who lives in a low-carbon home.

“Initially I was not comfortable with the air source heat pump, but once someone came round and showed me how to use the controls, I was able to set it to a temperature that suited me. I was also told to leave the system to run constantly which I didn’t think was right, but it must have been because my monthly bills went down from £100 to £60 per month. Now that I know how the systems works and how to control the temperature, I feel happy that this heating system is right. I like how the pump adjusts to the weather so that it’s never too hot or too cold. This has made living with my muscular dystrophy much easier.”

Your home (2)

Tell us about who owns your home.

- ○ Social housing/rented
- ○ Private/rented
- ○ Self-owned/mortgaged
- ○ Live with family or friends
- ○ Other

If you selected Other, please specify:

What if (retrofit rented home)

Imagine you are considering your landlord’s or housing association's offer to have your existing home refurbished as a low-carbon home, as presented in the video.

How much of an increase in monthly rent would you be willing to accept (in £)? Note that with the use of both solar panels and heat pump, typical savings from a home's yearly cost of heating and hot water are 30% to 40%.

By how much would your monthly rent have to be reduced (in £) ...

... if the radiators were increased in size by 20%?

... if the storage space in the home was reduced by 10% percent?

... if the outdoor unit of the heat pump took up 1 square meter of space from your garden/yard? Please put 0 if your home as it is does not have a garden/yard.

... if your refurbished home did not have additional insulation to reduce heat loss as much as possible?
Note that this insulation typically produce savings of 15% to 25% from a home's cost of heating and hot water.
Please put 0 if your home as it is already has additional insulation.

... if instead of a heat pump for heating and hot water, your refurbished home continued to use your existing system(s) for heating and hot water?
Note that a heat pump for heating and hot water typically produce savings of 20% to 26% from a home's cost of heating and hot water.

... if your refurbished home did not have a smart meter?* Please put 0 if your home as it is already has a smart meter.

*"Smart meters measure how much gas and electricity you're using via a remote connection to your energy supplier. They come with an in-home display screen to help you see how much energy you're using and whether you can reduce your energy consumption."

... if your refurbished home did not have a battery energy storage system for storing electricity from solar panels on the roof? Note that a battery energy storage system typically produces savings of 5% to 15% from a home's cost of heating and hot water. Please put 0 if your home as it is already has a battery energy storage system.

... if your refurbished home did not have solar panels on the roof? Note that with the use of solar panels typical savings from a home's yearly cost of heating and hot water are 15% to 40%. Please put 0 if your home as it is already has a solar panels on the roof.

What if - retrofit rented home

Imagine you are renting a home and are considering your landlord’s or housing association's offer to have your existing home refurbished as a low-carbon home, as presented in the video.

How much of an increase in monthly rent would you be willing to accept (in £)? Note that with the use of both solar panels and heat pump, typical savings from a home's yearly cost of heating and hot water are 30% to 40%.

By how much would your monthly rent have to be reduced (in £) ...

... if the radiators were increased in size by 20%?

... if the storage space in the home was reduced by 10% percent?

... if the outdoor unit of the heat pump took up 1 square meter of space from your

garden/yard? Please put 0 if your home as it is does not have a garden/yard.

... if your refurbished home did not have additional insulation to reduce heat loss as much as possible? Note that this insulation typically produce savings of 15% to 25% from a home's cost of heating and hot water. Please put 0 if your home as it is already has additional insulation.

... if instead of a heat pump for heating and hot water, your refurbished home continued to use your existing system(s) for heating and hot water?
Note that a heat pump for heating and hot water typically produce savings of 20% to 26% from a home's cost of heating and hot water.

... if your refurbished home did not have a smart meter?* Please put 0 if your home as it is already has a smart meter.

*"Smart meters measure how much gas and electricity you're using via a remote connection to your energy supplier. They come with an in-home display screen to help you see how much energy you're using and whether you can reduce your energy consumption."

... if your refurbished home did not have a battery energy storage system for storing electricity from solar panels on the roof? Note that a battery energy storage system typically produces savings of 5% to 15% from a home's cost of heating and hot water. Please put 0 if your home as it is already has a battery energy storage system.

... if your refurbished home did not have solar panels on the roof? Note that with the use of solar panels typical savings from a home's yearly cost of heating and hot water are 15% to 40%. Please put 0 if your home as it is already has a solar panels on the roof.

What if (retrofit self-owned home)

Imagine you are considering having your self-owned existing home refurbished as a low-carbon home, as presented in the video.

Compared to refurbishment of your home without low-carbon technology, at what additional cost would you be willing to have your home refurbished with low-carbon technology (in £)? Note that with the use of both solar panels and heat pump, typical savings from a home's yearly cost of heating and hot water are 30% to 40%.

By how much would your refurbishment cost have to be reduced (in £) ...

... if the radiators were increased in size by 20%?

... if the storage space in the home was reduced by 10% percent?

... if the outdoor unit of the heat pump took up 1 square meter of space from your garden/yard? Please put 0 if your home as it is does not have a garden/yard.

... if your refurbished home did not have additional insulation to reduce heat loss as much as possible? Note that this insulation typically produce savings of 15% to 25% from a home's cost of heating and hot water. Please put 0 if your home as it is already has additional insulation.

... if instead of a heat pump for heating and hot water, your refurbished home continued to use your existing system(s) for heating and hot water? Note that a heat pump for heating and hot water typically produce savings of 20% to 26% from a home's cost of heating and hot water.

... if your refurbished home did not have a smart meter?* Please put 0 if your home as it is already has a smart meter.

*"Smart meters measure how much gas and electricity you're using via a remote connection to your energy supplier. They come with an in-home display screen to help you see how much energy you're using and whether you can reduce your energy consumption."

... if your refurbished home did not have a battery energy storage system for storing electricity from solar panels on the roof? Note that a battery energy storage system

typically produces savings of 5% to 15% from a home’s cost of heating and hot water. Please put 0 if your home as it is already has a battery energy storage system.

... if your refurbished home did not have solar panels on the roof? Note that with the use of solar panels typical savings from a home’s yearly cost of heating and hot water are 15% to 40%. Please put 0 if your home as it is already has a solar panels on the roof.

Low-carbon technologies and instructions for answering following questions

Please state the low-carbon technologies in your home (tick all that apply).

- ☐ Solar panels on the roof
- ☐ Battery/Battery energy storage system
- ☐ Efficient thermal insulation solutions (such as wall-, floor-, roof insulation and double glazing) to stop heat loss from your home
- ☐ Smart meter

When answering the following questions please choose one of the presented answers. For example, in some of the questions, the end-point answers are 1 (strongly disagree) and 7 (strongly agree). In-between values (2, 3, 4, 5 and 6) then indicate a degree of (dis)agreement between these two end-points.

Please note that where a low-carbon home is mentioned in the following questions, then think about the low-carbon home that you have seen in the video.

Intention

I intend to live in a low-carbon home and use low-carbon technologies within the next 10 years.

- 1 Definitely do
- 2
- 3
- 4
- 5
- 6
- 7 Definitely do not

I am willing to live in a low-carbon home and use low-carbon technologies within the next 10 years.

- 1 Agree
- 2
- 3
- 4
- 5
- 6
- 7 Disagree

I want to live in a low-carbon home and use low-carbon technologies within the next 10 years.

- 1 Agree
- 2

- 3
- 4
- 5
- 6
- 7 Disagree

I am likely to live in a low-carbon home and use low-carbon technologies within the next 10 years.

- 1 Disagree
- 2
- 3
- 4
- 5
- 6
- 7 Agree

I have decided to live in a low-carbon home and use low-carbon technologies within the next 10 years.

- 1 Disagree
- 2
- 3
- 4
- 5
- 6
- 7 Agree

I am planning to live in a low-carbon home and use low-carbon technologies within the next 10 years.

- 1 Disagree
- 2
- 3
- 4
- 5
- 6
- 7 Agree

Attitude

My living in a low-carbon home and using low-carbon technologies within the next 10 years would be

- 1 Bad
- 2
- 3
- 4
- 5
- 6
- 7 Good

My living in a low-carbon home and using low-carbon technologies within the next 10 years would be

- 1 Pleasant
- 2
- 3
- 4
- 5
- 6
- 7 Unpleasant

My living in a low-carbon home and using low-carbon technologies within the next 10 years would be

- 1 Harmful
- 2

- 3
- 4
- 5
- 6
- 7 Beneficial

My living in a low-carbon home and using low-carbon technologies within the next 10 years would be

- 1 Interesting
- 2
- 3
- 4
- 5
- 6
- 7 Boring

My living in a low-carbon home and using low-carbon technologies within the next 10 years would be

- 1 Foolish
- 2
- 3
- 4
- 5
- 6
- 7 Wise

My living in a low-carbon home and using low-carbon technologies within the next 10 years would be

- 1 Relaxing
- 2
- 3
- 4
- 5
- 6
- 7 Unrelaxing

My living in a low-carbon home and using low-carbon technologies within the next 10 years would be

- 1 Useful
- 2
- 3
- 4
- 5
- 6
- 7 Useless

My living in a low-carbon home and using low-carbon technologies within the next 10 years would be

- 1 Enjoyable
- 2
- 3
- 4

- 5
- 6
- 7 Unenjoyable

Other people in general in relation to low-carbon homes

Most people who are important to me approve of my living in a low-carbon home and using low-carbon technologies within the next 10 years.

- 1 Agree
- 2
- 3
- 4
- 5
- 6
- 7 Disagree

The people in my life whose opinions I value would approve of my living in a low-carbon home and using low-carbon technologies within the next 10 years.

- 1 Agree
- 2
- 3
- 4
- 5
- 6
- 7 Disagree

It is expected of me that I live in a low-carbon home and use low-carbon technologies within the next 10 years.

- 1 Agree
- 2

- 3
- 4
- 5
- 6
- 7 Disagree

Most people like me live in a low-carbon home and use low-carbon technologies.

- 1 Unlikely
- 2
- 3
- 4
- 5
- 6
- 7 Likely

Prove you're paying attention. Choose Disagree.

- Strongly disagree
- Disagree
- Somewhat disagree
- Neither agree nor disagree
- Somewhat agree
- Agree
- Strongly agree

The people in my life whose opinions I value live in a low-carbon home and use low-

carbon technologies.

- 1 Agree
- 2
- 3
- 4
- 5
- 6
- 7 Disagree

Most people who are important to me live in a low-carbon home and using low-carbon technologies.

- 1 Agree
- 2
- 3
- 4
- 5
- 6
- 7 Disagree

Capacity and control

I am confident that I can live in a low-carbon home and use low-carbon technologies within the next 10 years.

- 1 True
- 2
- 3
- 4
- 5
- 6
- 7 False

My living in a low-carbon home and using low-carbon technologies within the next 10 years is up to me.

- 1 Disagree
- 2
- 3
- 4
- 5
- 6
- 7 Agree

Living in a low-carbon home and using low-carbon technologies within the next 10 years is under my control.

- 1 Disagree
- 2

- 3
- 4
- 5
- 6
- 7 Agree

I have the resources, knowledge, and ability to live in a low-carbon home and using low-carbon technologies within the next 10 years.

- 1 Disagree
- 2
- 3
- 4
- 5
- 6
- 7 Agree

There are few outside events that could prevent me from living in a low-carbon home and using low-carbon technologies within the next 10 years.

- 1 Definitely false
- 2
- 3
- 4
- 5
- 6
- 7 Definitely true

I am capable of living in a low-carbon home and using low-carbon technologies within the next 10 years.

- 1 Definitely false
- 2
- 3
- 4
- 5
- 6
- 7 Definitely true

For me to live in a low-carbon home and using low-carbon technologies within the next 10 years would be

- 1 Completely impossible
- 2
- 3
- 4
- 5
- 6
- 7 Definitely possible

Living in a low-carbon home and using low-carbon technologies within the next 10 years is beyond my personal control

- 1 Definitely false
- 2
- 3
- 4

- 5
- 6
- 7 Definitely true

Possible outcomes of living in a low-carbon home

My living in a low-carbon home and using low-carbon technologies within the next 10 years will result in reducing my energy bills/service charges.

- 1 Likely
- 2
- 3
- 4
- 5
- 6
- 7 Unlikely

Reducing my energy bills/service charges is

- 1 Good
- 2
- 3
- 4
- 5
- 6
- 7 Bad

My living in a low-carbon home and using low-carbon technologies within the next 10 years will result in improved health for myself and my family (for example no or reduced breathing complaints).

- 1 Likely
- 2

- 3
- 4
- 5
- 6
- 7 Unlikely

Improved health for myself and my family (for example no or reduced breathing complaints) is

- 1 Good
- 2
- 3
- 4
- 5
- 6
- 7 Bad

My living in a low-carbon home and using low-carbon technologies within the next 10 years will result in improved wellbeing for myself and my family (for example, pride to live in a low-carbon home).

- 1 Likely
- 2
- 3
- 4
- 5
- 6
- 7 Unlikely

Improved wellbeing for myself and my family (for example, pride to live in a low-carbon home) is

- 1 Good
- 2
- 3
- 4
- 5
- 6
- 7 Bad

My living in a low-carbon home and using low-carbon technologies within the next 10 years will result in protection of the environment through reduced energy use in the home.

- 1 Likely
- 2
- 3
- 4
- 5
- 6
- 7 Unlikely

Protection of the environment through reduced energy use in the home is

- 1 Good
- 2
- 3
- 4

- 5
- 6
- 7 Bad

My living in a low-carbon home and using low-carbon technologies within the next 10 years will encourage other people to switch to living in a low-carbon home.

- 1 Likely
- 2
- 3
- 4
- 5
- 6
- 7 Unlikely

Encouragement for other people to switch to living in a low-carbon home is

- 1 Good
- 2
- 3
- 4
- 5
- 6
- 7 Bad

My living in a low-carbon home and using low-carbon technologies within the next 10 years will give me a reliable source of energy through solar panels.

- 1 Likely
- 2
- 3
- 4
- 5
- 6
- 7 Unlikely

Having a reliable source of energy through solar panels is

- 1 Good
- 2
- 3
- 4
- 5
- 6
- 7 Bad

My living in a low-carbon home and using low-carbon technologies within the next 10 years will make me feel virtuous: living more sustainably and protecting the environment against climate change.

- 1 Likely
- 2
- 3
- 4
- 5
- 6
- 7 Unlikely

Feeling virtuous because of living more sustainably and protecting the environment against climate change is

- 1 Good
- 2
- 3
- 4
- 5
- 6
- 7 Bad

My living in a low-carbon home and using low-carbon technologies within the next 10 years will make me feel secure because of having a reliable source of energy through solar panels.

- 1 Likely
- 2
- 3
- 4
- 5
- 6
- 7 Unlikely

Feeling secure because of having a reliable source of energy through solar panels is

- 1 Good

- 2
- 3
- 4
- 5
- 6
- 7 Bad

My living in a low-carbon home and using low-carbon technologies within the next 10 years will result in increasing my energy bills/service charges.

- 1 Likely
- 2
- 3
- 4
- 5
- 6
- 7 Unlikely

Increasing my energy bills/service charges is

- 1 Good
- 2
- 3
- 4
- 5
- 6
- 7 Bad

My living in a low-carbon home and using low-carbon technologies within the next 10 years will result in consistently reduced availability of hot water and electricity.

- 1 Likely
- 2
- 3
- 4
- 5
- 6
- 7 Unlikely

Consistently reduced availability of hot water and electricity is

- 1 Good
- 2
- 3
- 4
- 5
- 6
- 7 Bad

My living in a low-carbon home and using low-carbon technologies within the next 10 years will result in reduced indoor living space.

- 1 Likely
- 2
- 3
- 4
- 5

- 6
- 7 Unlikely

Reduced indoor living space is

- 1 Good
- 2
- 3
- 4
- 5
- 6
- 7 Bad

My living in a low-carbon home and using low-carbon technologies within the next 10 years will result in a rent increase.

- 1 Likely
- 2
- 3
- 4
- 5
- 6
- 7 Unlikely
- 8 I do not rent a home or do not rent from a housing association

A rent increase is

- 1 Good
- 2
- 3
- 4
- 5
- 6
- 7 Bad
- 8 I do not rent a home or do not rent from a housing association

Specific other people in relation to low-carbon homes

When answering the following question please choose one of the presented answers. The end-point answers are 1 (should) and 7 (should not). In-between values (2, 3, 4, 5 and 6) then indicate a degree of belief between these two end-points. To what extent do you believe your friends/family/neighbours think that
you should live in a low-carbon home within the next 10 years.

- 1 I should
- 2
- 3
- 4
- 5
- 6
- 7 I should not

When it comes to matters of sustainable living, I want to do what my friends/family/neighbours think I should do.

- 1 Agree
- 2
- 3
- 4
- 5
- 6
- 7 Disagree

When answering the following question please choose one of the presented answers. The end-point answers are 1 (should) and 7 (should not). In-between values (2, 3, 4, 5 and 6) then indicate a degree of belief between these two end-points. To what extent do

you believe your landlord or housing association thinks that you should live in a low-carbon home and using low-carbon technologies within the next 10 years.

- 1 I should
- 2
- 3
- 4
- 5
- 6
- 7 I should not
- 8 I do not rent a home or do not rent from a housing association

When it comes to matters of sustainable living, I want to do what my landlord or housing association thinks I should do.

- 1 Agree
- 2
- 3
- 4
- 5
- 6
- 7 Disagree
- 8 I do not rent a home or do not rent from a housing association

Most of my friends/family/neighbours live in a low-carbon home and used low-carbon technologies.

- 1 False
- 2

- 3
- 4
- 5
- 6
- 7 True

When it comes to matters of sustainable living, how much do you want to be like your friends/family/neighbours?

- 1 Very much
- 2
- 3
- 4
- 5
- 6
- 7 Not at all

Most residents who rent from the same landlord or housing association as I do live in a low-carbon home and use low-carbon technologies.

- 1 False
- 2
- 3
- 4
- 5
- 6
- 7 True
- 8 I do not rent a home or do not rent from a housing association

When it comes to matters of sustainable living, how much do you want to be like residents who rent from the same landlord or housing association as you do ?

- 1 Very much
- 2
- 3
- 4
- 5
- 6
- 7 Not at all
- 8 I do not rent a home or do not rent from a housing association

Specific external factors

I expect that I will receive support from the government or local authority to install low-carbon technology in my home.

- 1 Likely
- 2
- 3
- 4
- 5
- 6
- 7 Unlikely

Support from the government or local authority to install low-carbon technology in my home would enable me to live in a low-carbon home and using low-carbon technologies within the next 10 years.

- 1 Disagree
- 2
- 3
- 4
- 5
- 6
- 7 Agree

I expect that the heat pump controls in my low-carbon technology home will be accessible to manage the system.

- 1 Likely
- 2

- 3
- 4
- 5
- 6
- 7 Unlikely

Accessible heat pump controls in my low-carbon technology home to manage the system would enable me to live in a low-carbon home and using low-carbon technologies within the next 10 years.

- 1 Disagree
- 2
- 3
- 4
- 5
- 6
- 7 Agree

I expect the home energy system in my low-carbon technology home will be affordable to operate.

- 1 Likely
- 2
- 3
- 4
- 5
- 6
- 7 Unlikely

An affordable-to-operate home energy system would enable me to live in a low-carbon home and using low-carbon technologies within the next 10 years.

- 1 Disagree
- 2
- 3
- 4
- 5
- 6
- 7 Agree

I expect that my low-carbon home will have insufficient space for a storage tank.

- 1 Likely
- 2
- 3
- 4
- 5
- 6
- 7 Unlikely

Having insufficient space for a storage tank would prevent me from living in a low-carbon home and using low-carbon technologies within the next 10 years.

- 1 Disagree
- 2
- 3
- 4
- 5

- 6
- 7 Agree

I expect that heat pump installation will cause disruption to living in my low-carbon home.

- 1 Likely
- 2
- 3
- 4
- 5
- 6
- 7 Unlikely

Heat pump installation causing disruption would prevent me from living in a low-carbon home and using low-carbon technologies within the next 10 years.

- 1 Disagree
- 2
- 3
- 4
- 5
- 6
- 7 Agree

I expect that, living in my low-carbon home, it will be difficult to get the heat pump system repaired when necessary.

- 1 Likely
- 2
- 3
- 4
- 5
- 6
- 7 Unlikely

Difficulty in getting the heat pump system repaired when necessary would prevent me from living in a low-carbon home and using low-carbon technologies within the next 10 years.

- 1 Disagree
- 2
- 3
- 4
- 5
- 6
- 7 Agree

Prove you're paying attention. Choose Agree.

- Strongly disagree
- Disagree
- Somewhat disagree
- Neither agree nor disagree
- Somewhat agree
- Agree

- Strongly agree

I expect that I will have insufficient knowledge and skills regarding how to operate my low-carbon home.

- 1 Likely
- 2
- 3
- 4
- 5
- 6
- 7 Unlikely

Having insufficient knowledge and skills regarding how to operate my low-carbon home would prevent me from living in a low-carbon home and using low-carbon technologies within the next 10 years.

- 1 Disagree
- 2
- 3
- 4
- 5
- 6
- 7 Agree

I expect that the heat pump on the outside of my low-carbon home will look unappealing.

- 1 Likely

- 2
- 3
- 4
- 5
- 6
- 7 Unlikely

Poor visual appeal of heat pump on the outside would prevent me from living in a low-carbon home and using low-carbon technologies within the next 10 years.

- 1 Disagree
- 2
- 3
- 4
- 5
- 6
- 7 Agree

End of survey

End of survey - thank you for taking part.

Kindly click here to submit your response.

Key for selection options

3 - What is your age?

under 18
18
19
20
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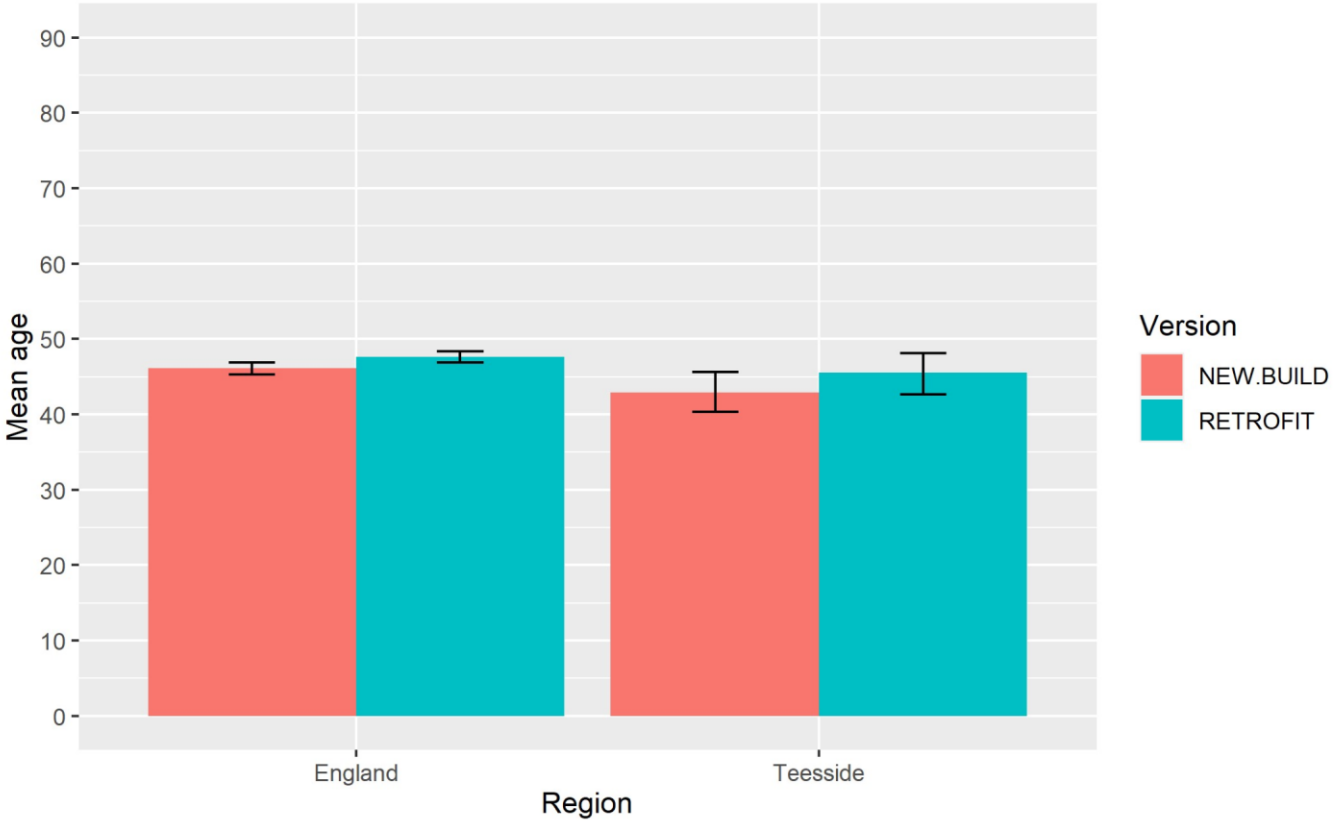
Part 2. Comparative survey of Tees Valley residents' and national responses to low-carbon technologies in the home – Appendix B - graphs

Paul van Schaik
Centre for Applied Psychological Science
Teesside University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Mean age
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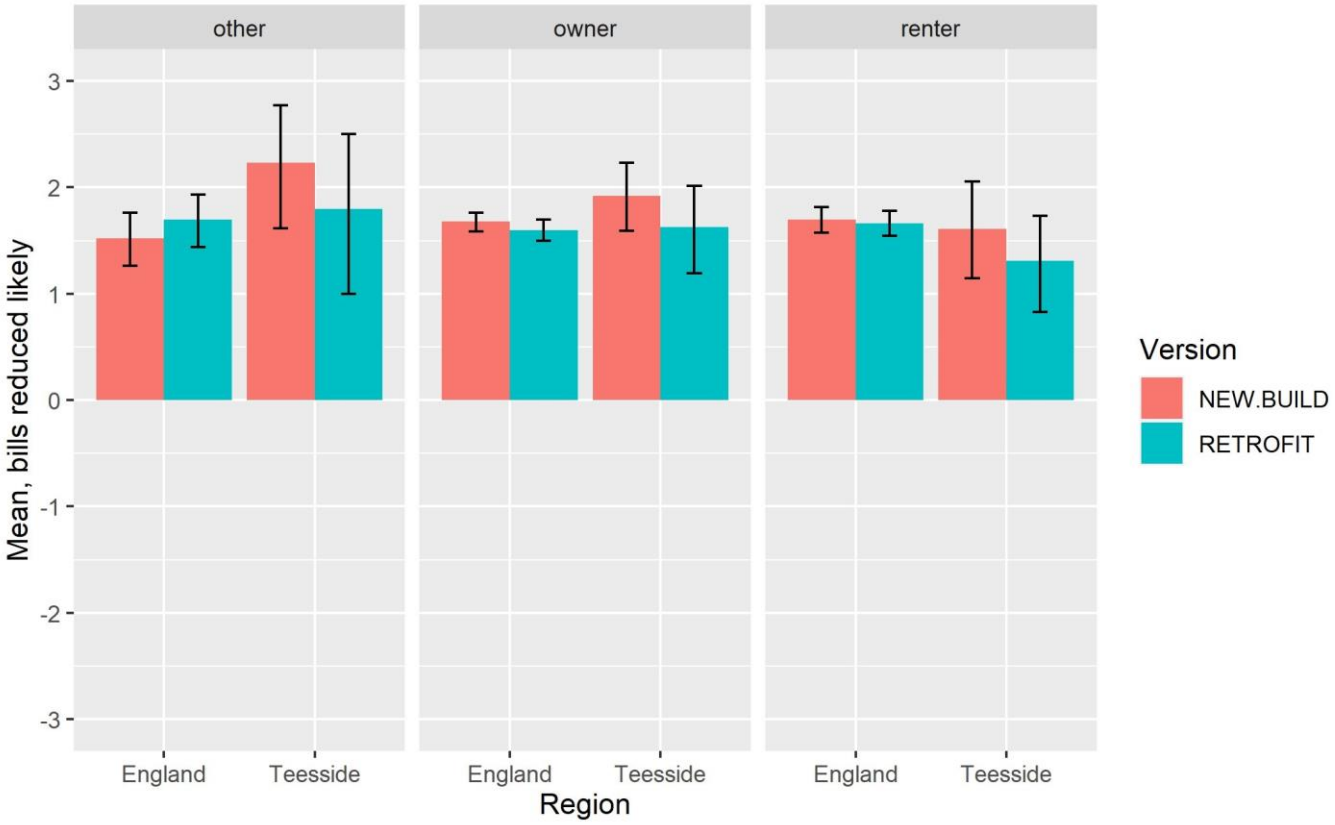
other
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Mean, bills reduced likely
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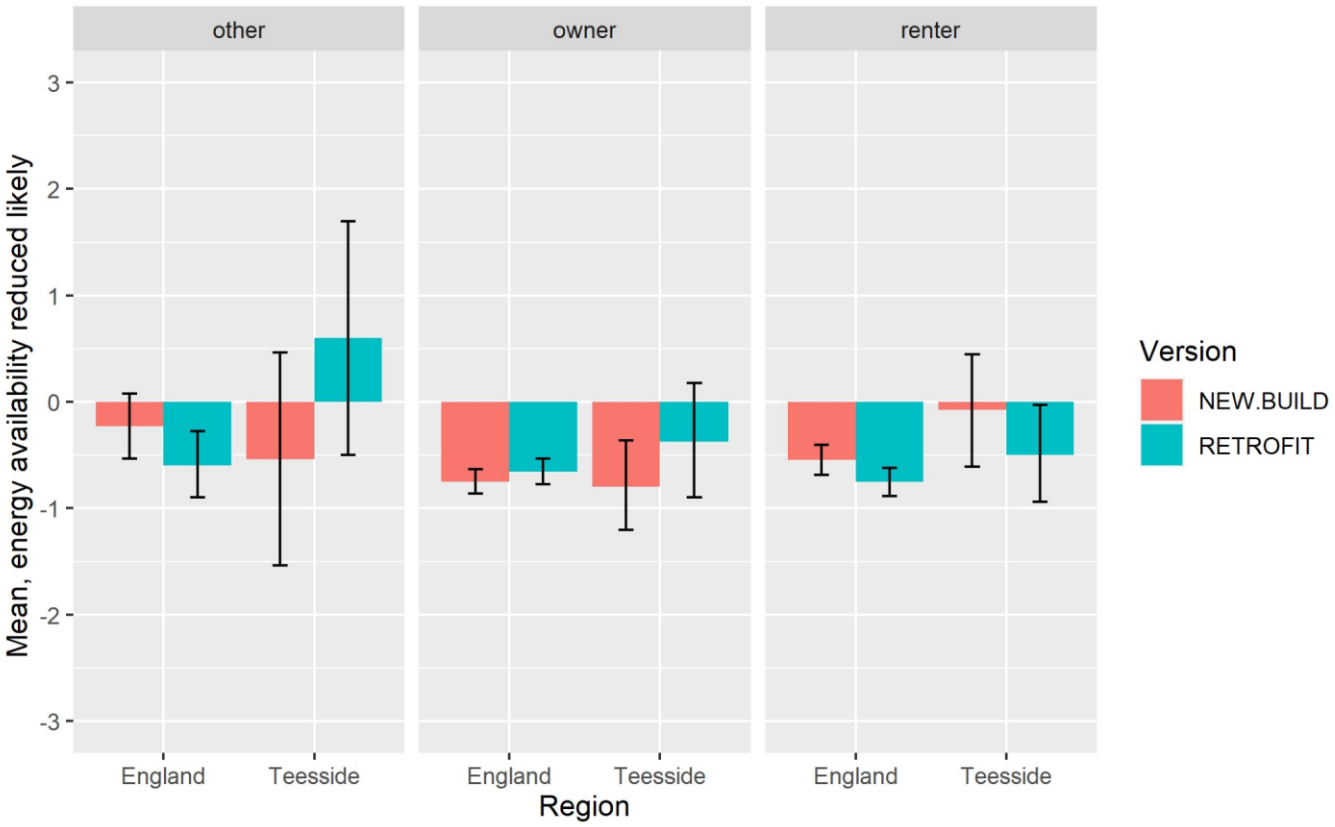
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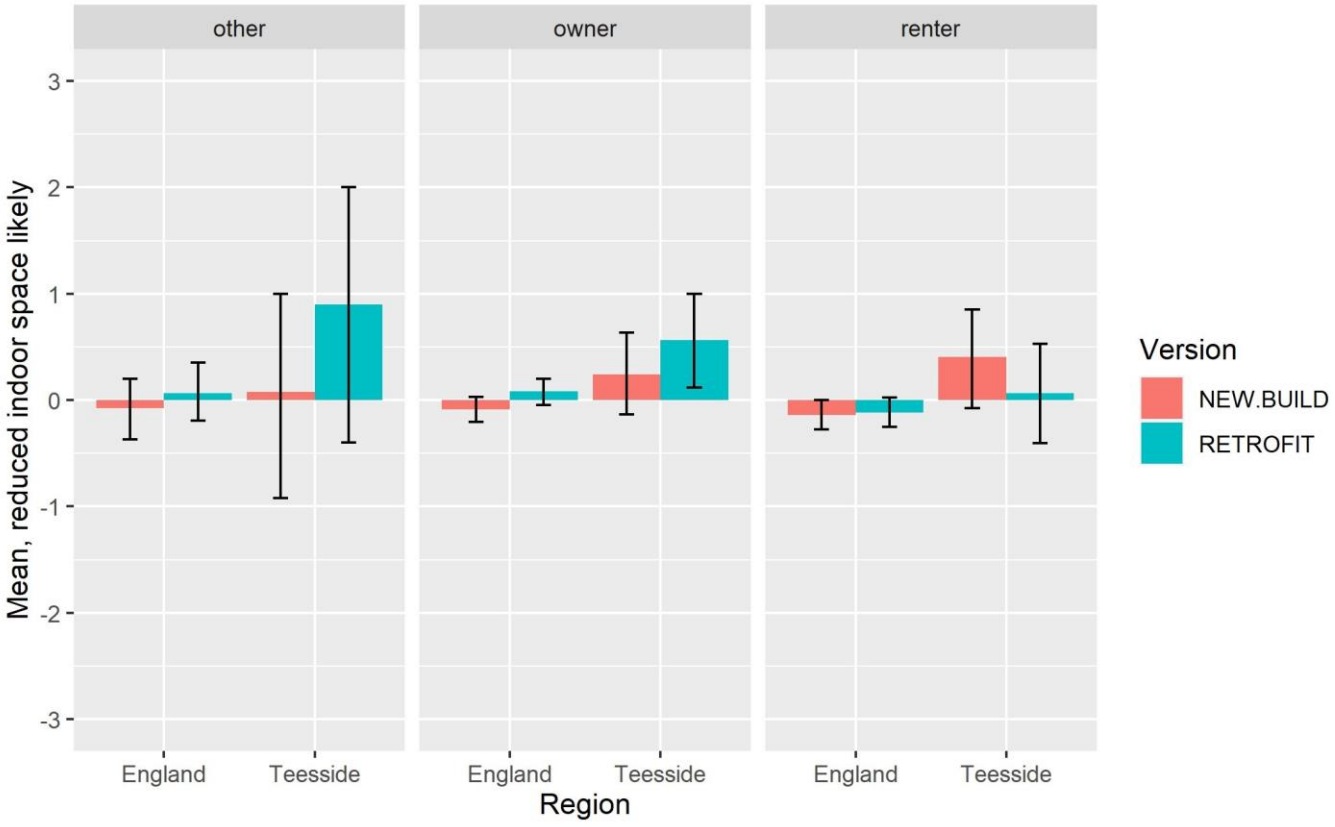
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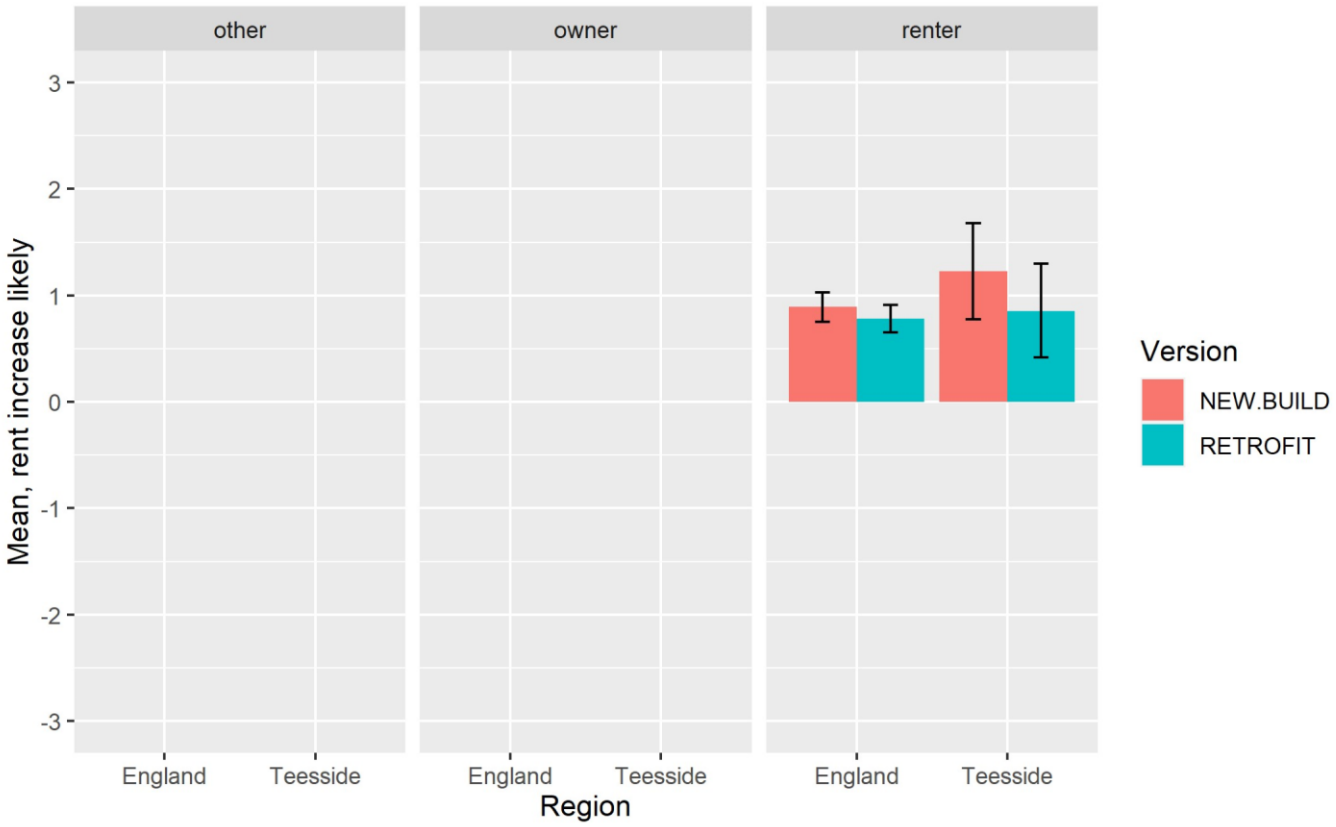
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Mean, rent increase likely
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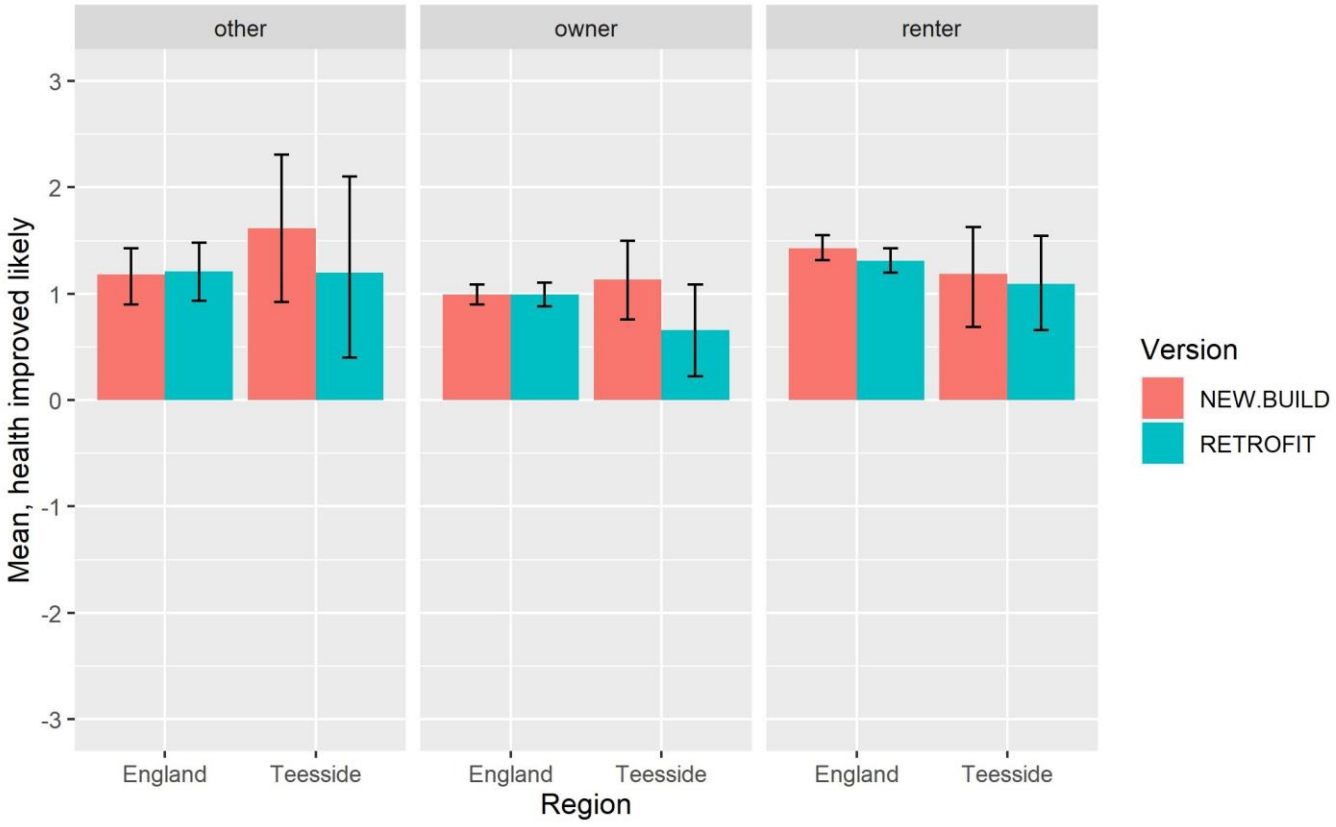
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Mean, health improved likely
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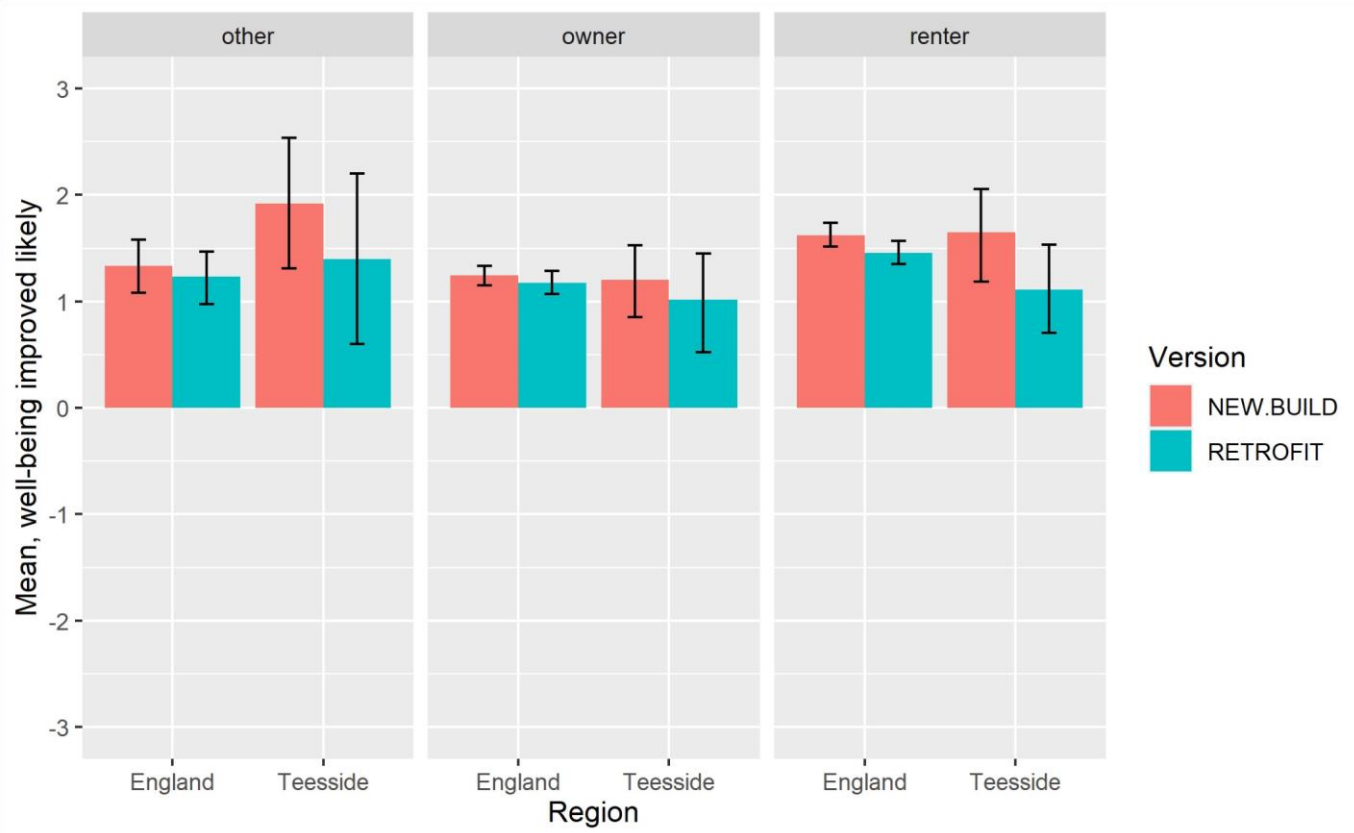
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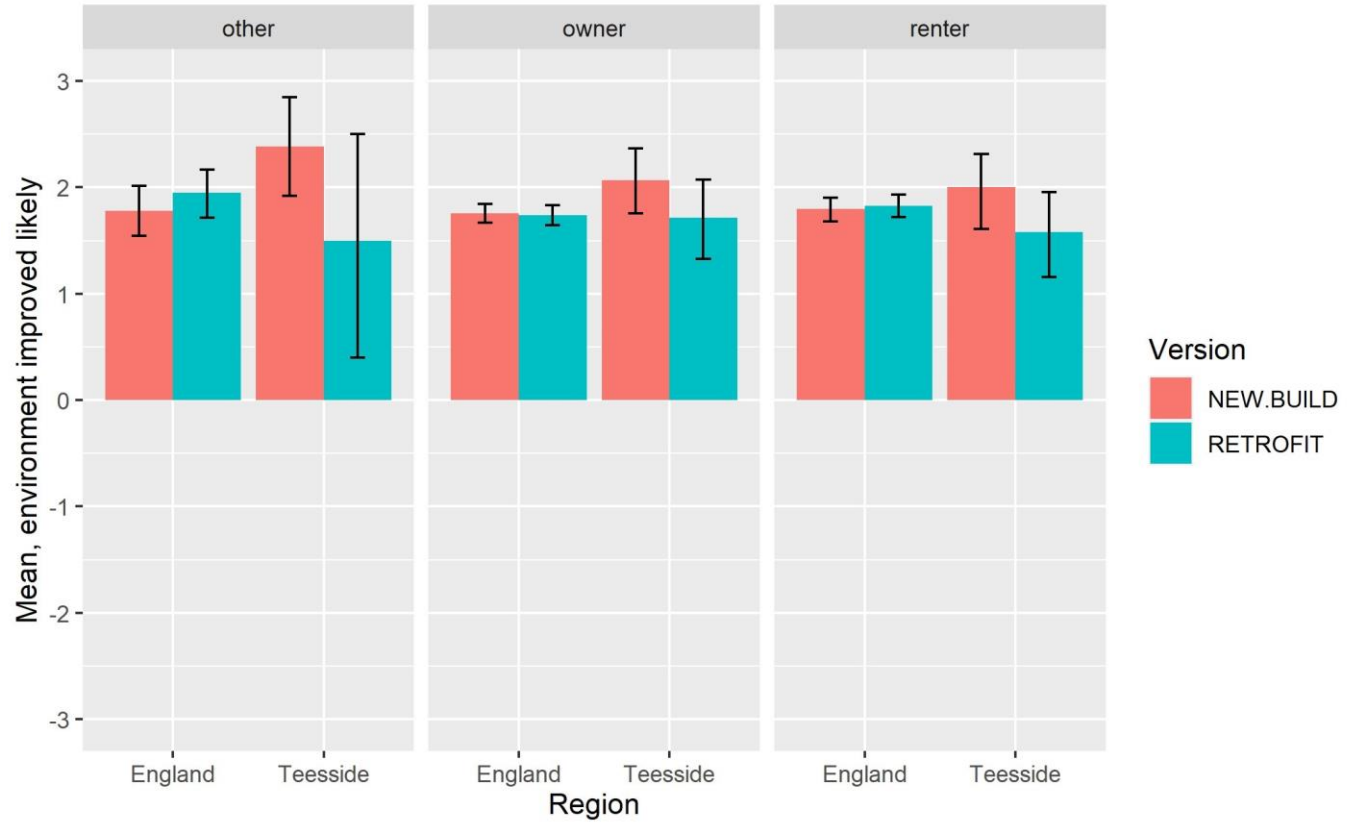
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Mean, environment improved likely
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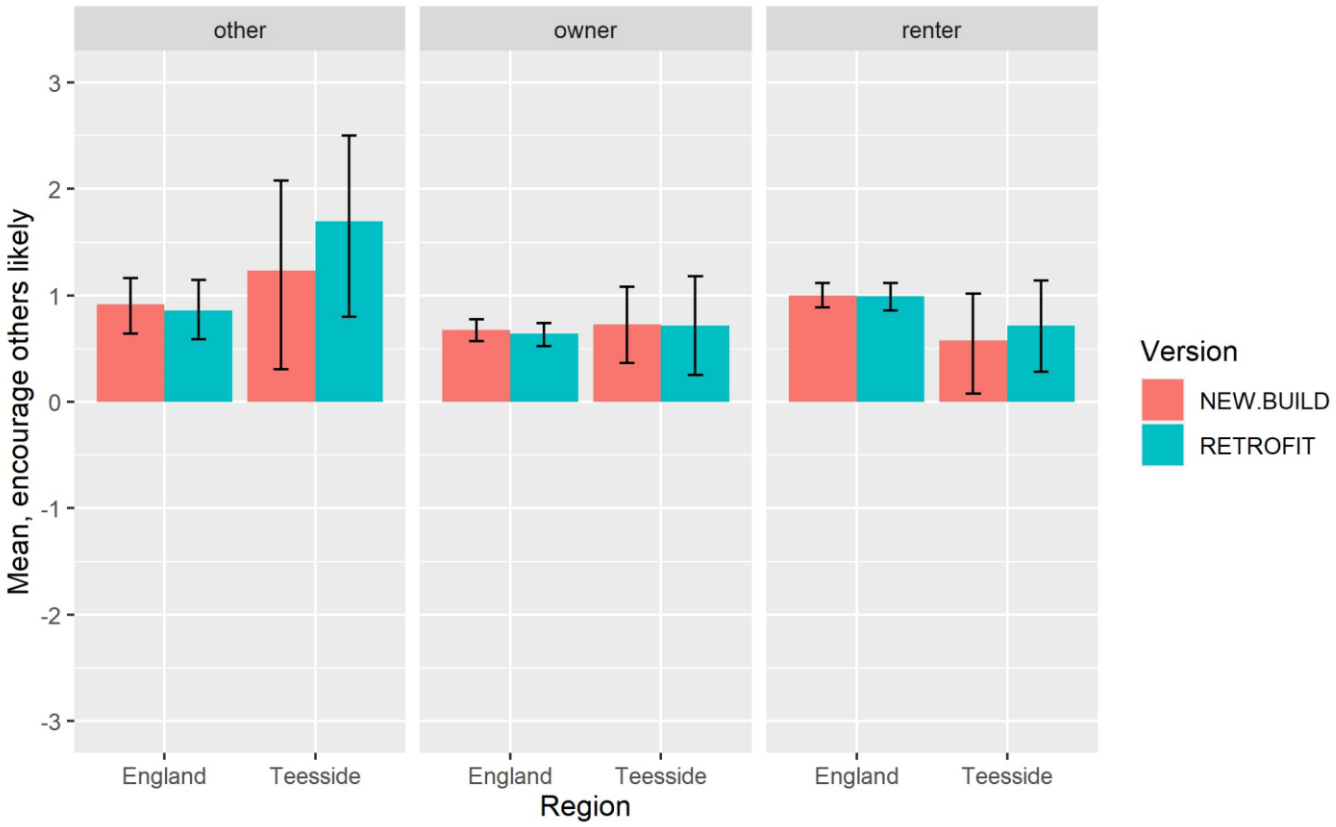
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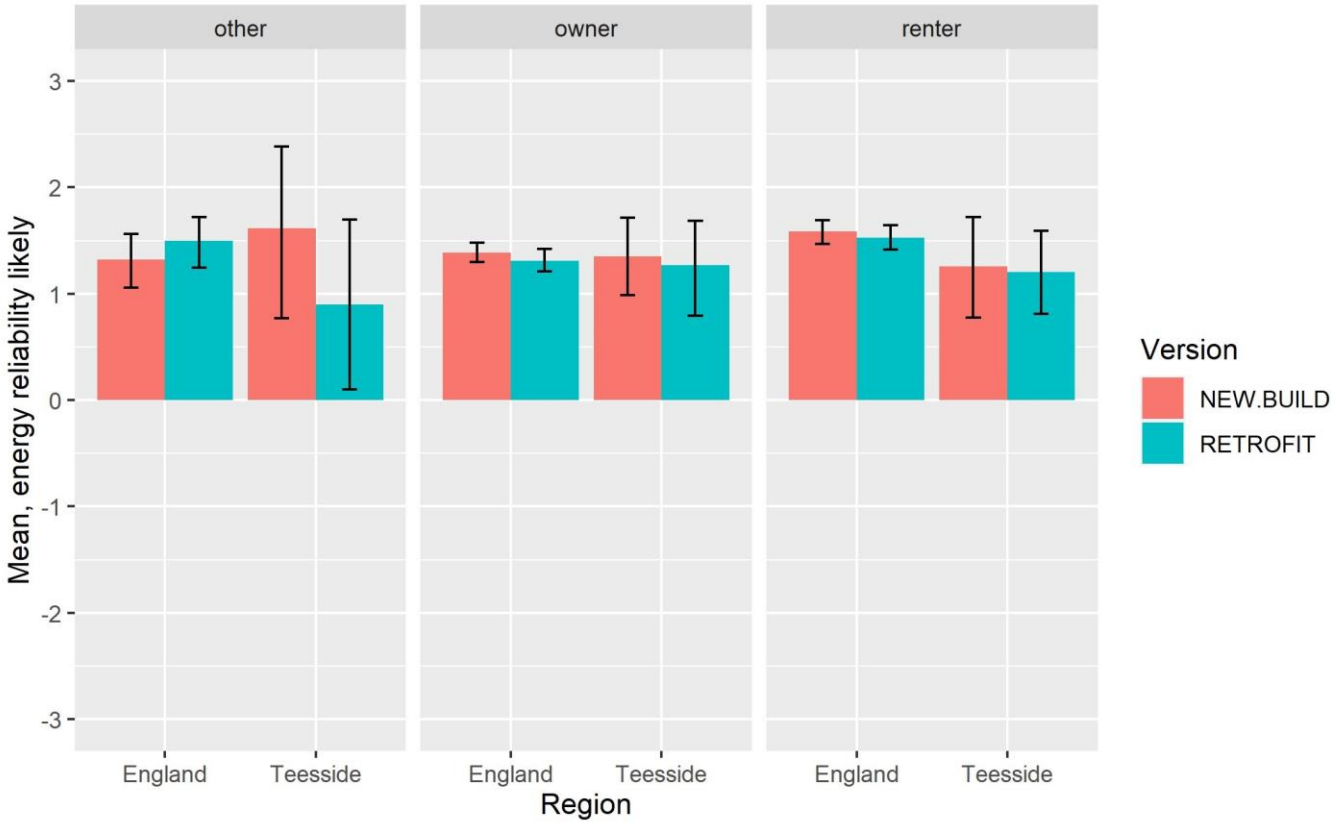
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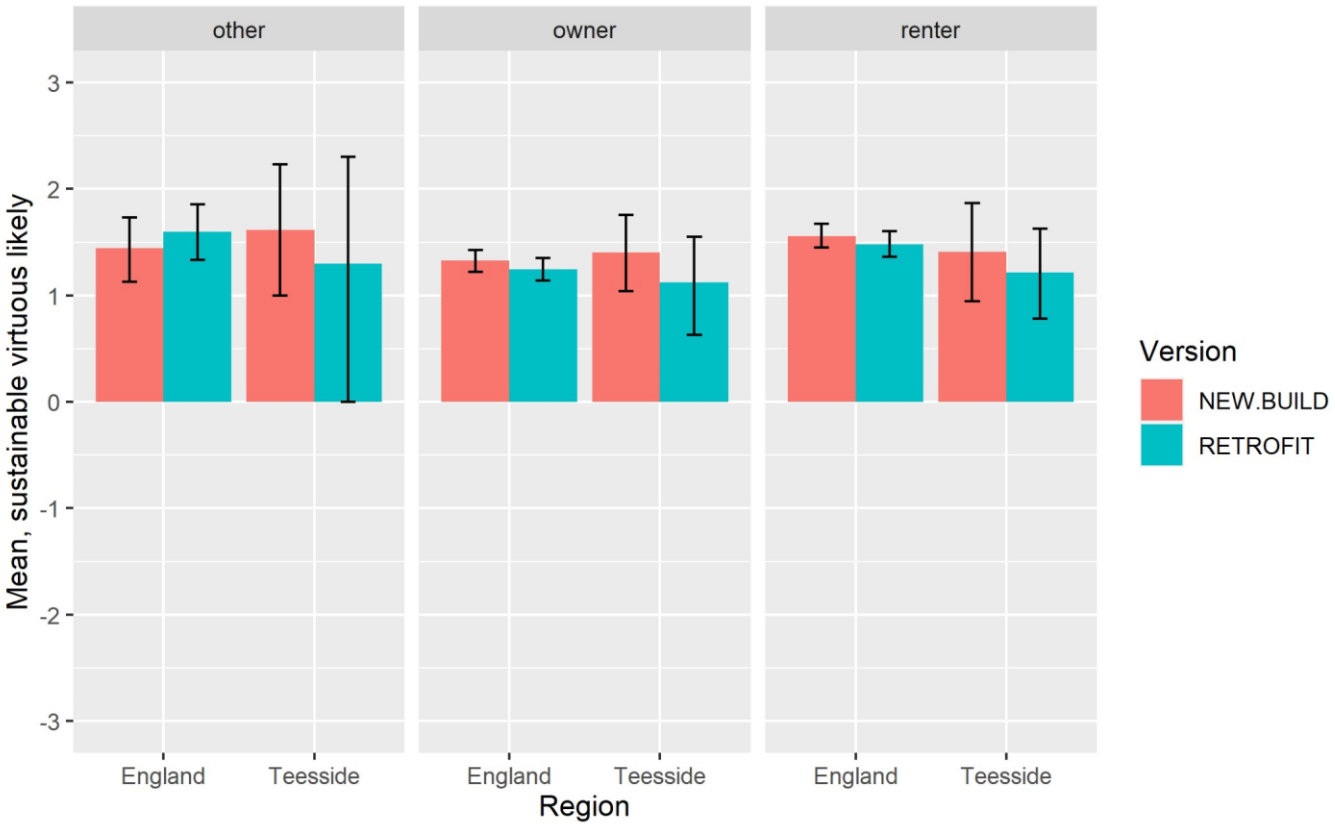
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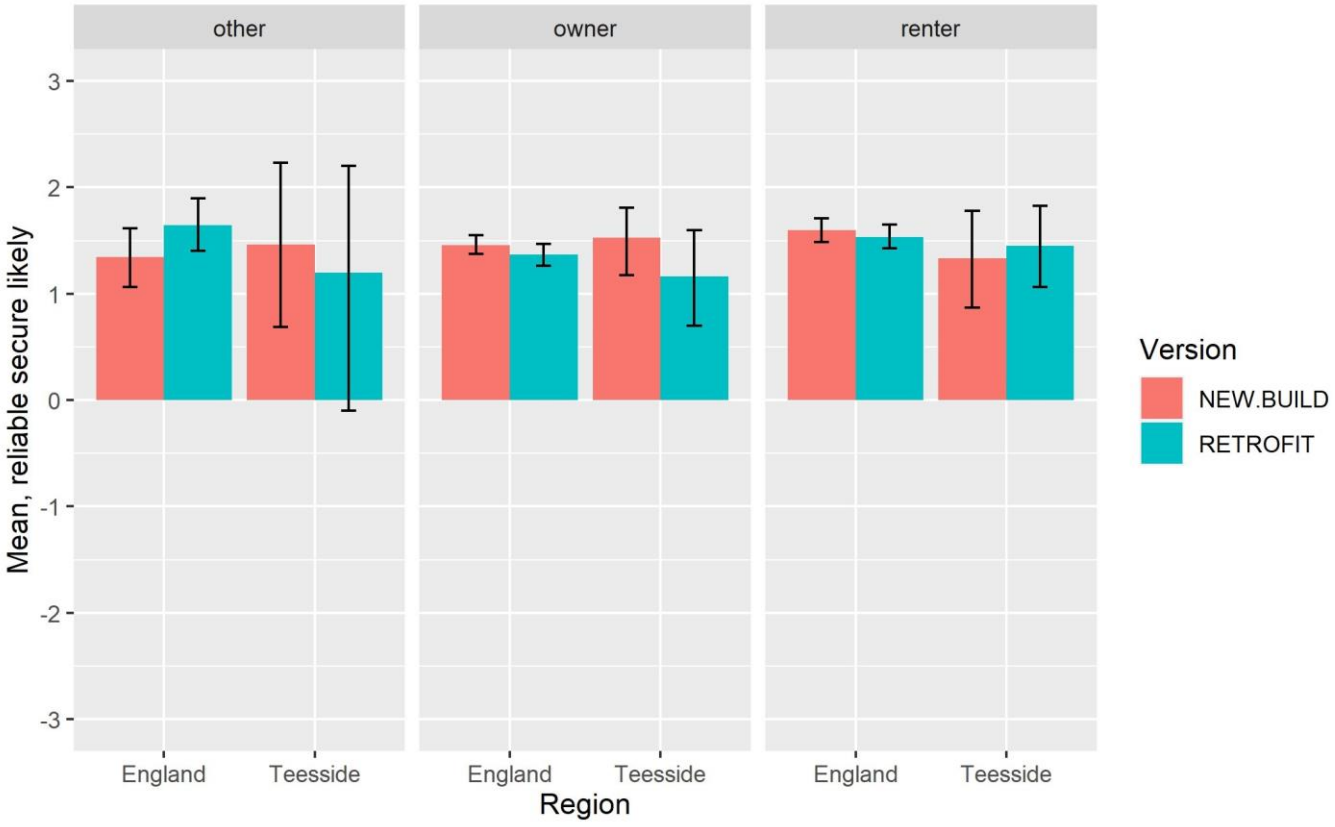
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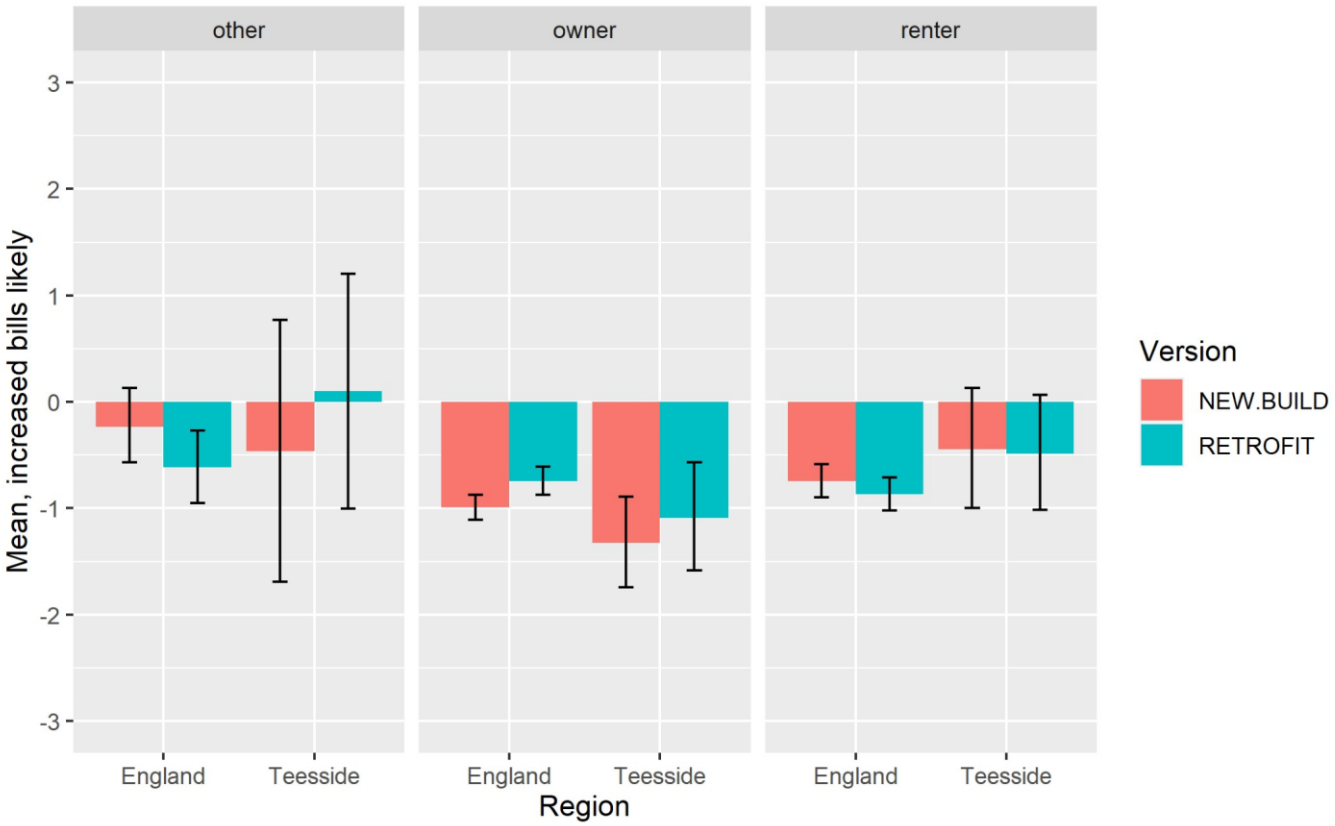
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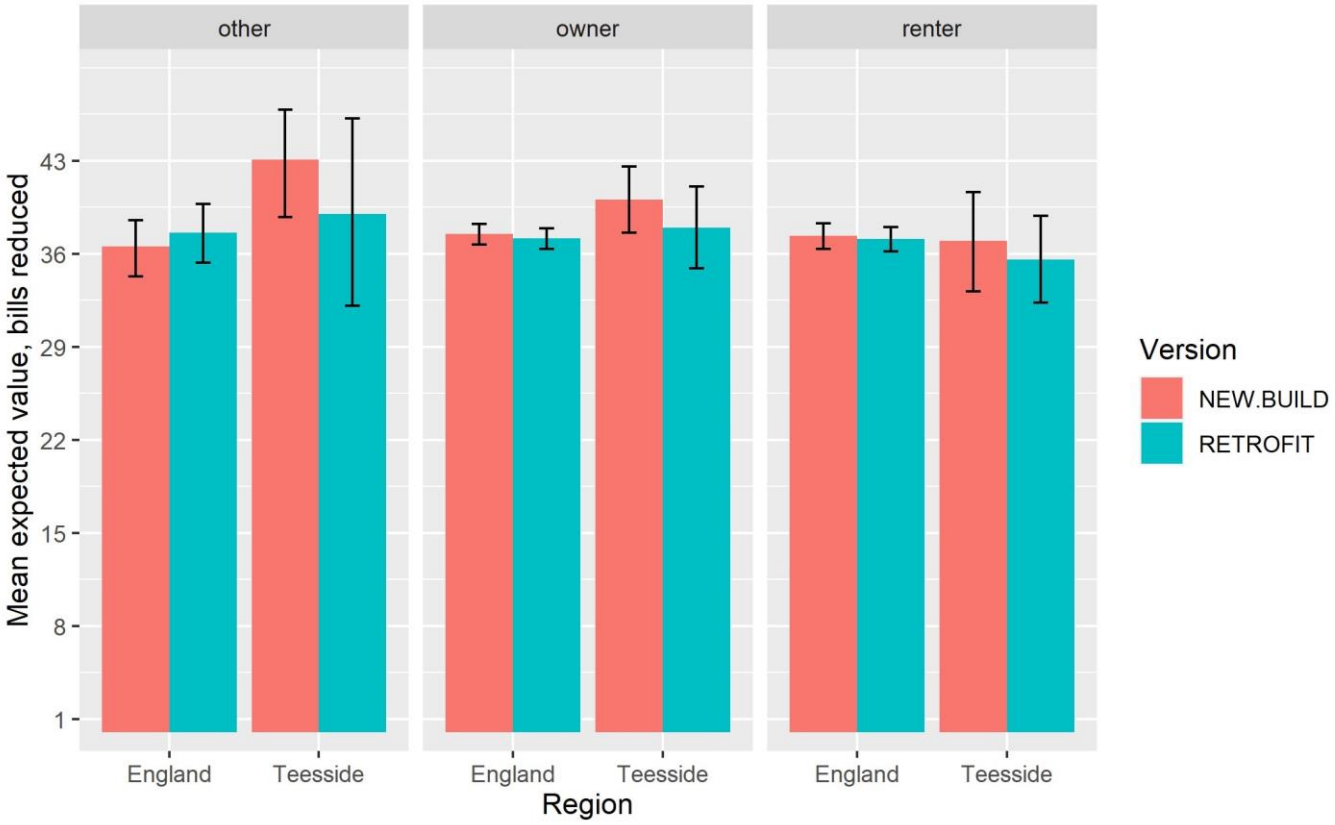
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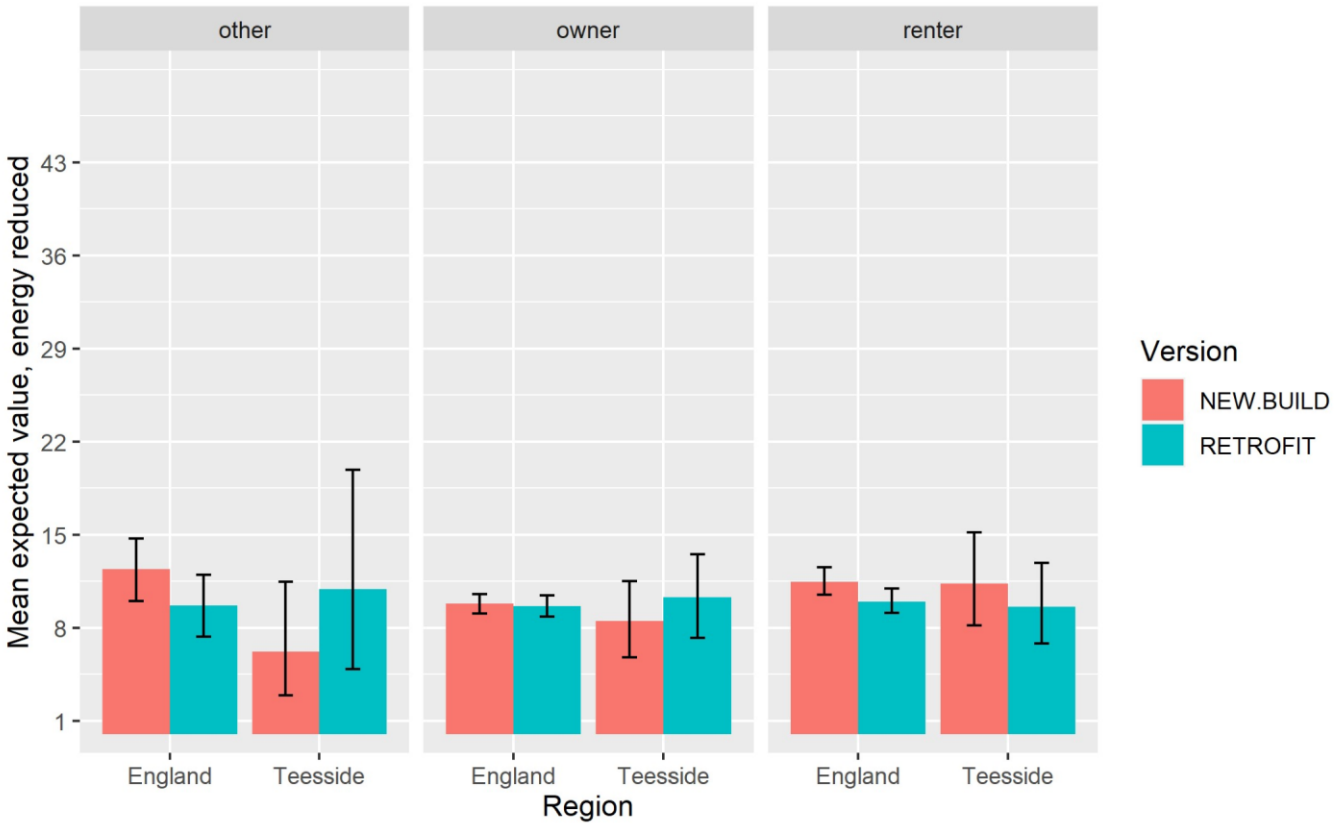
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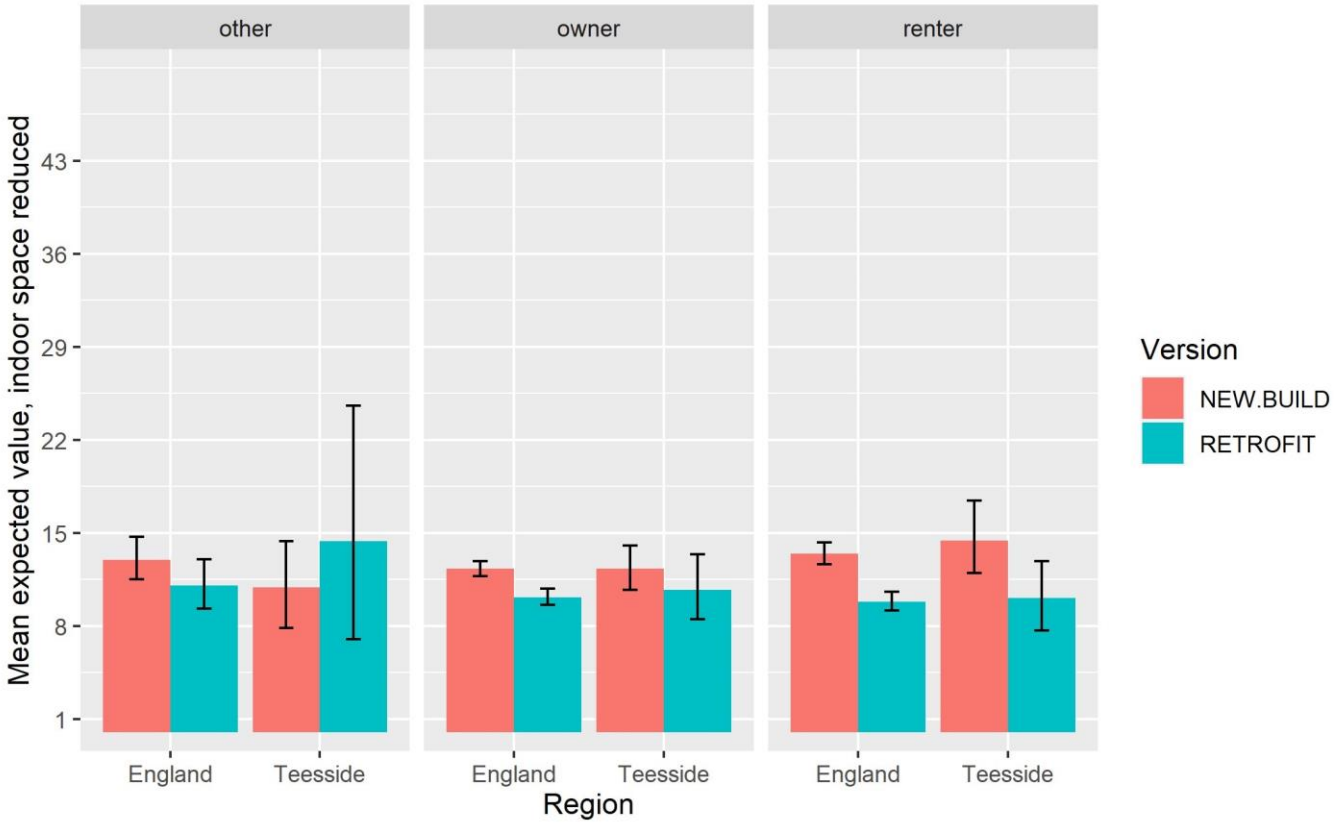
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Mean expected value, indoor space reduced
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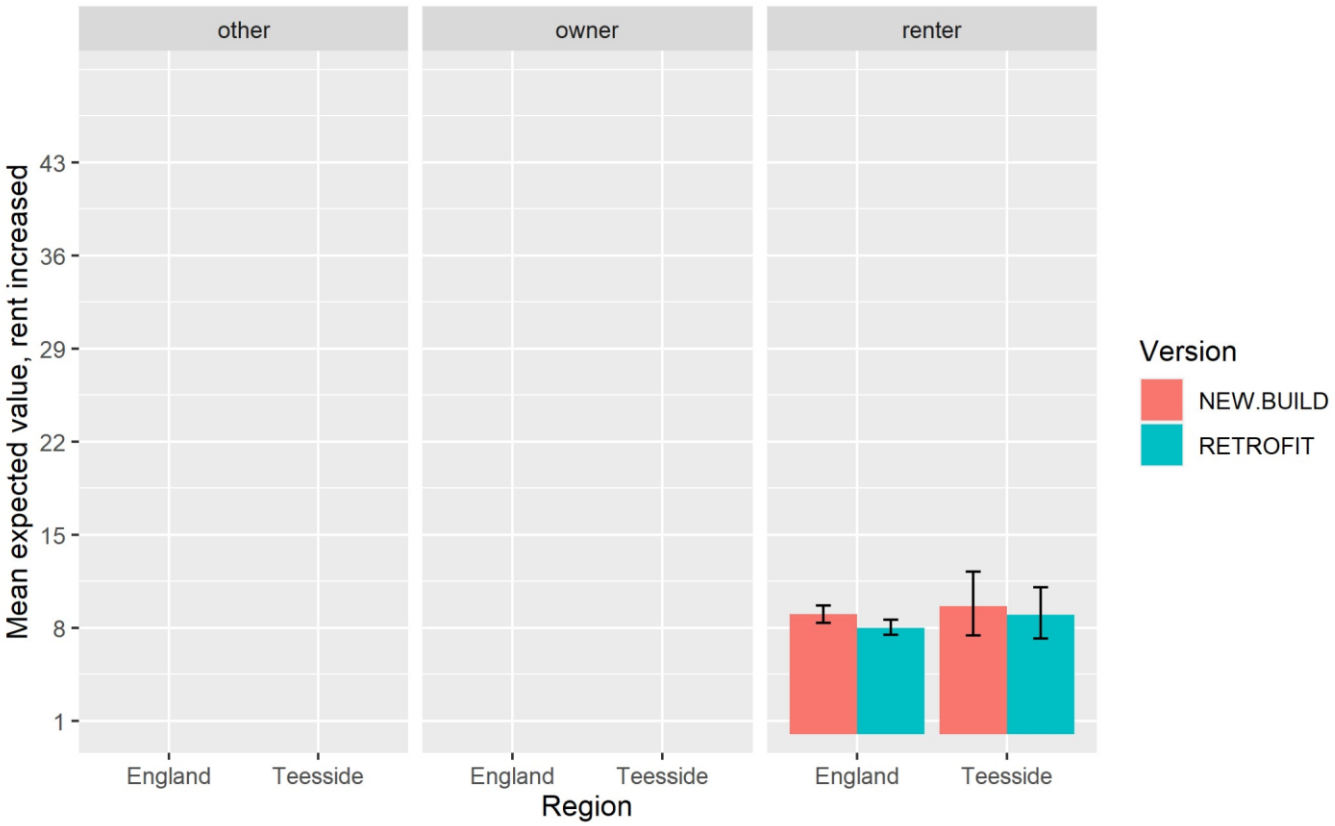
other
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renter
Mean expected value, rent increased
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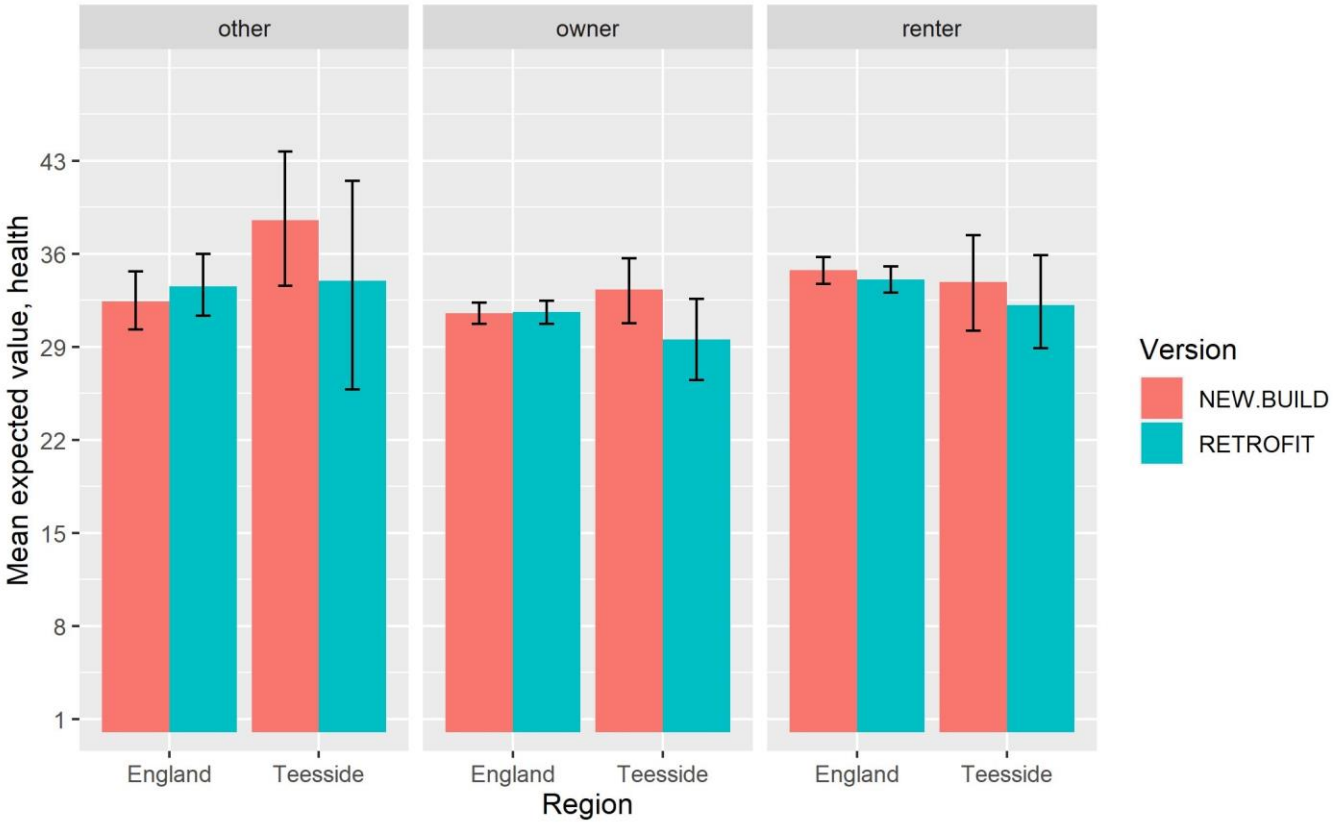
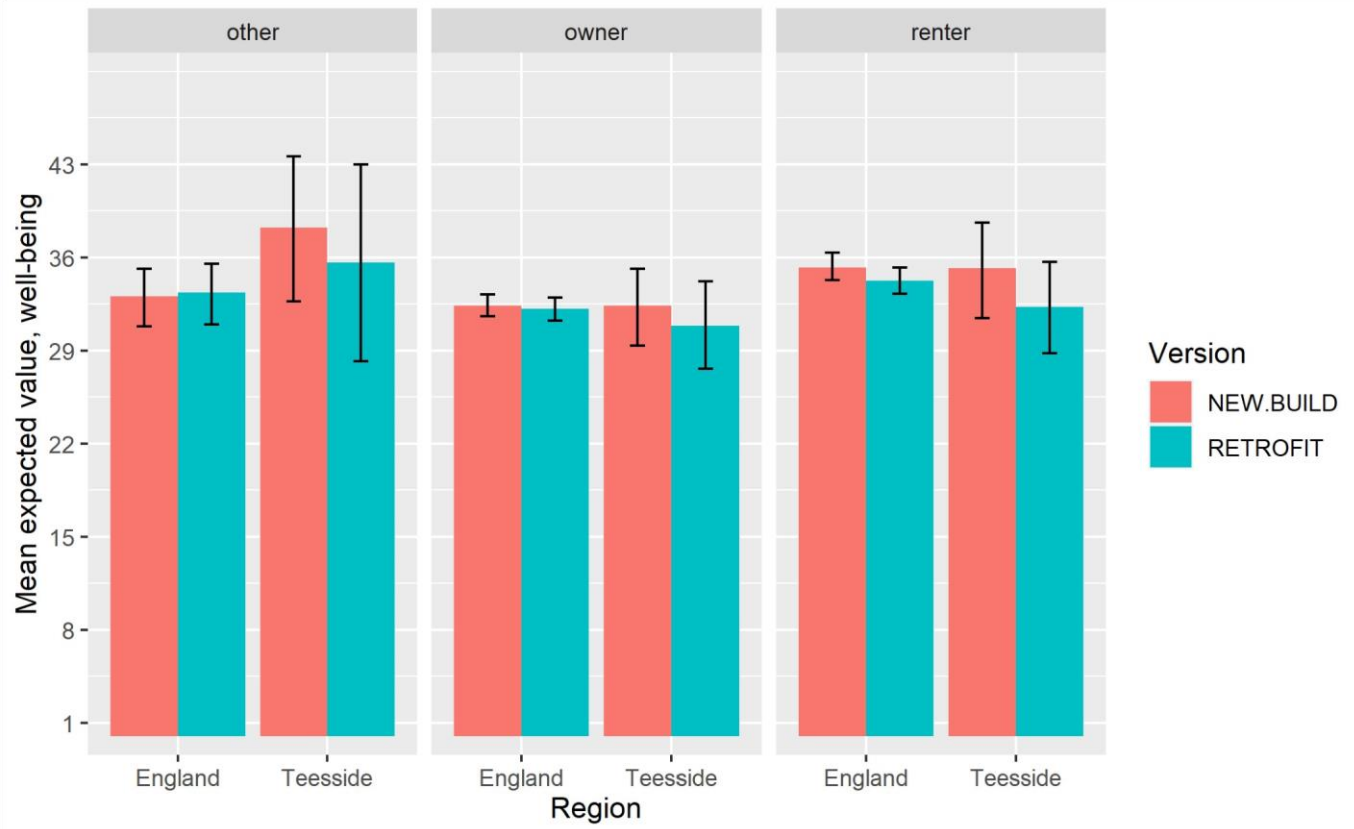
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean expected value, health
43
36
29
22
15
8
1
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean expected value, well-being
43
36
29
22
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8
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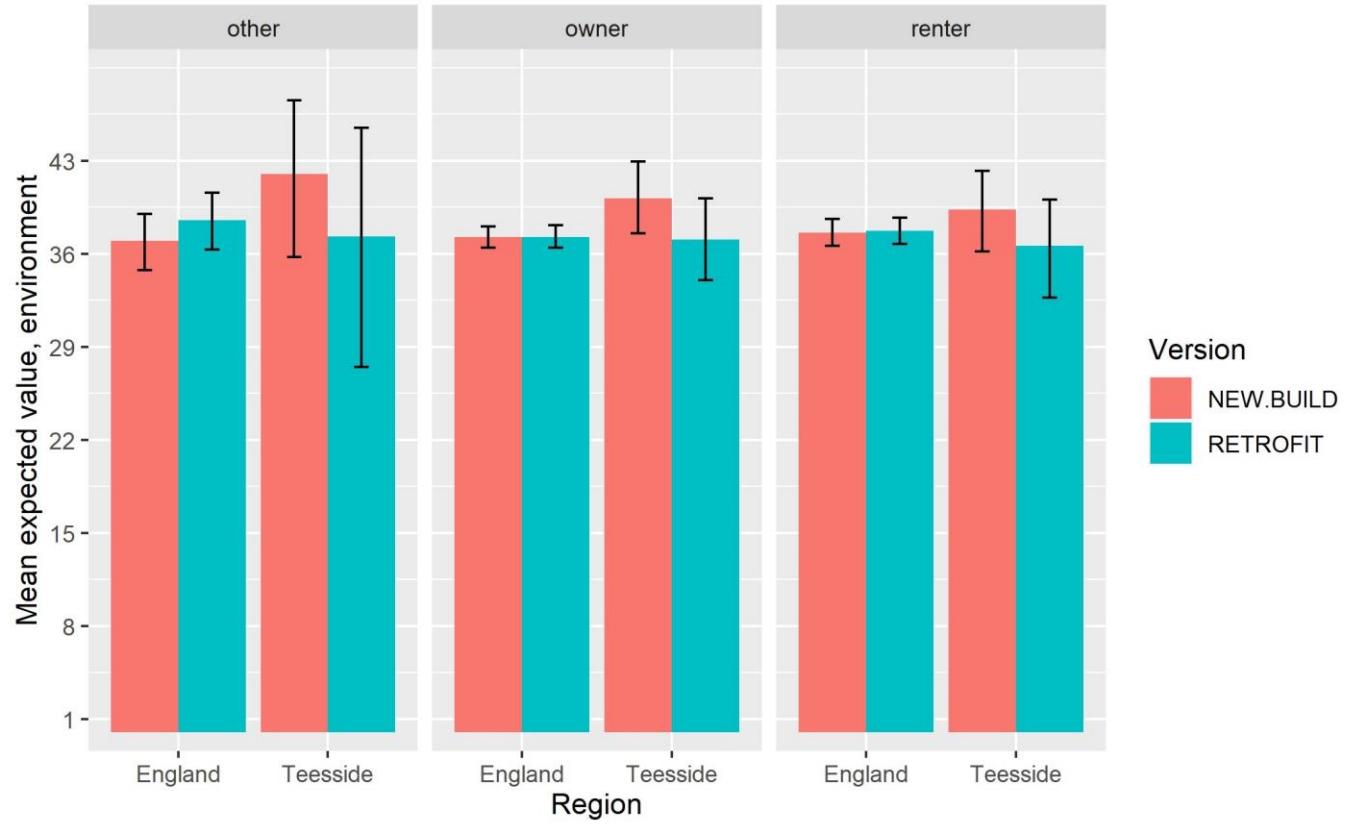
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean expected value, environment
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36
29
22
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8
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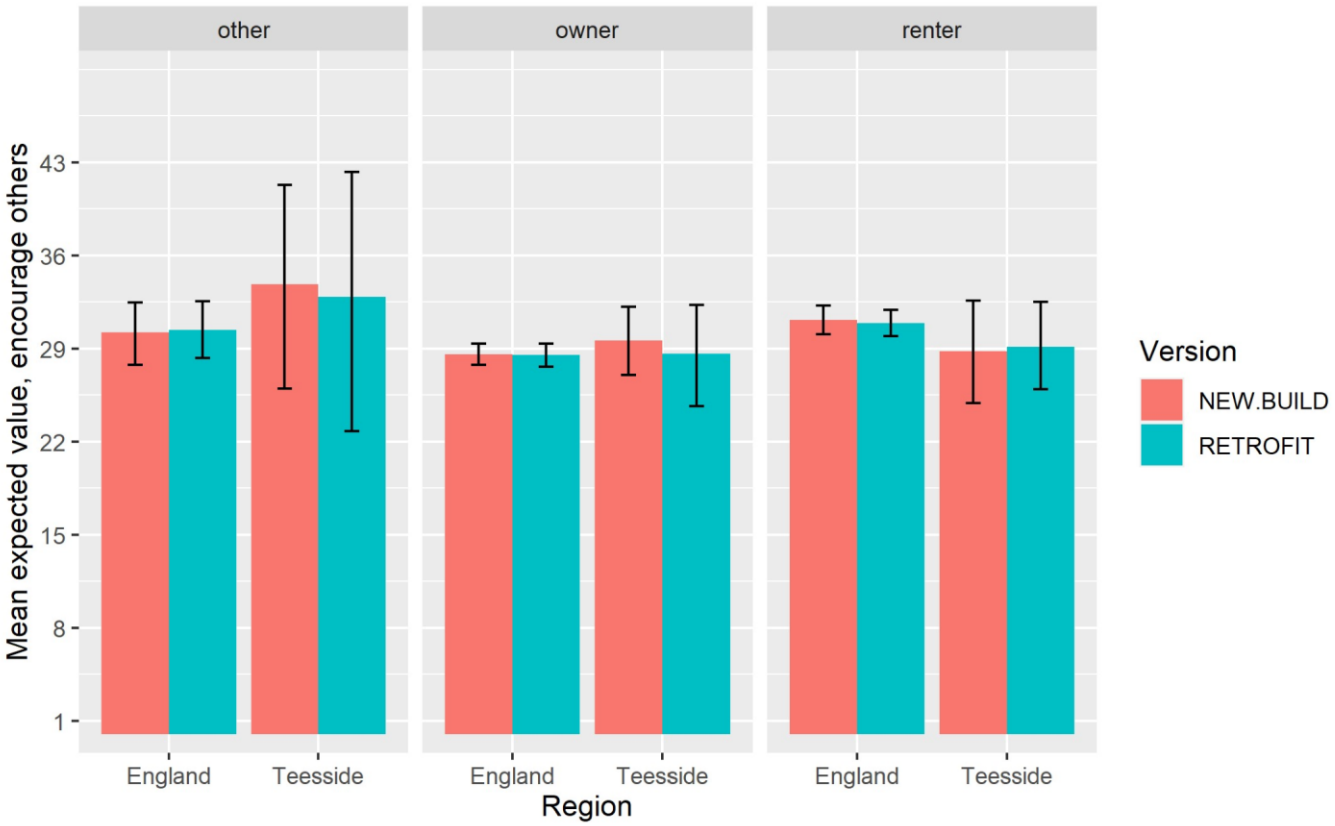
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean expected value, encourage others
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36
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22
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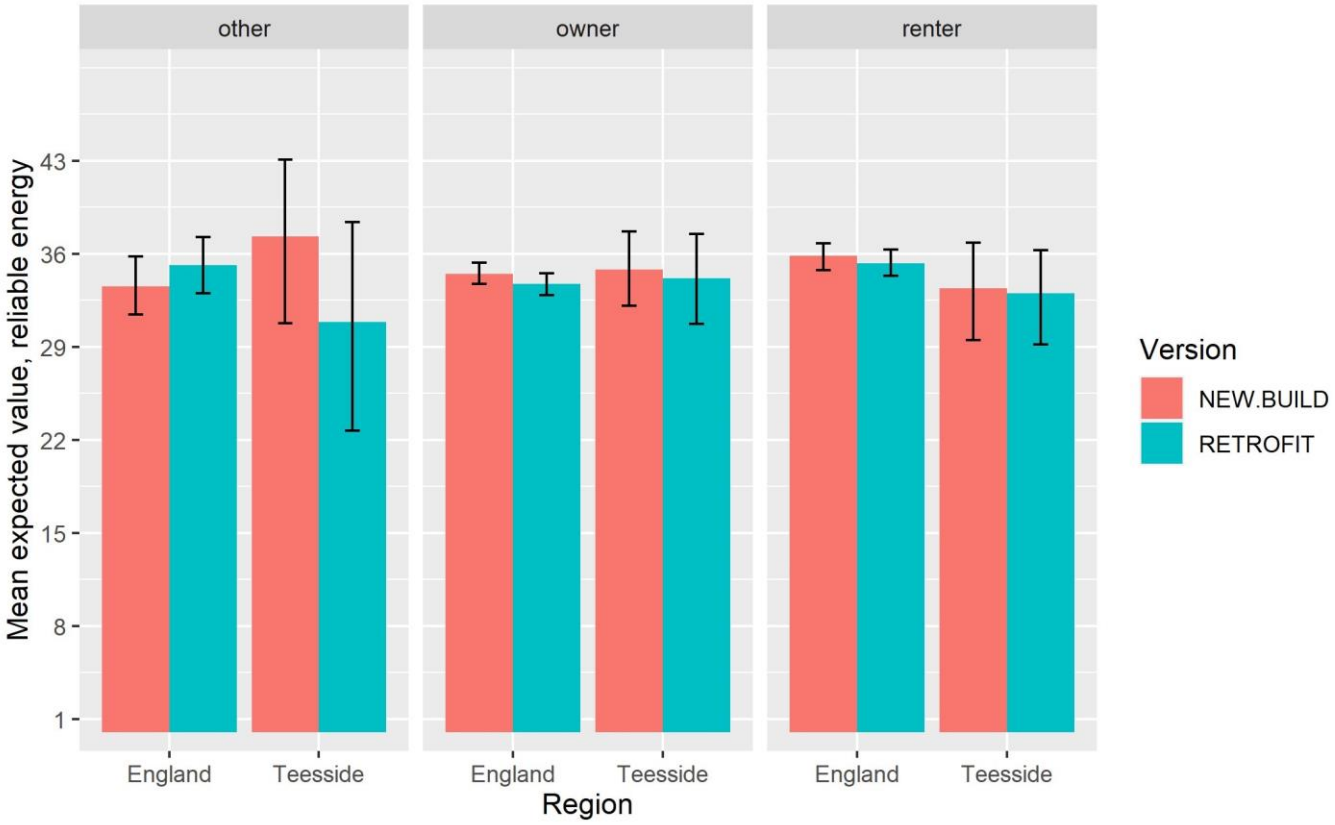
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean expected value, reliable energy
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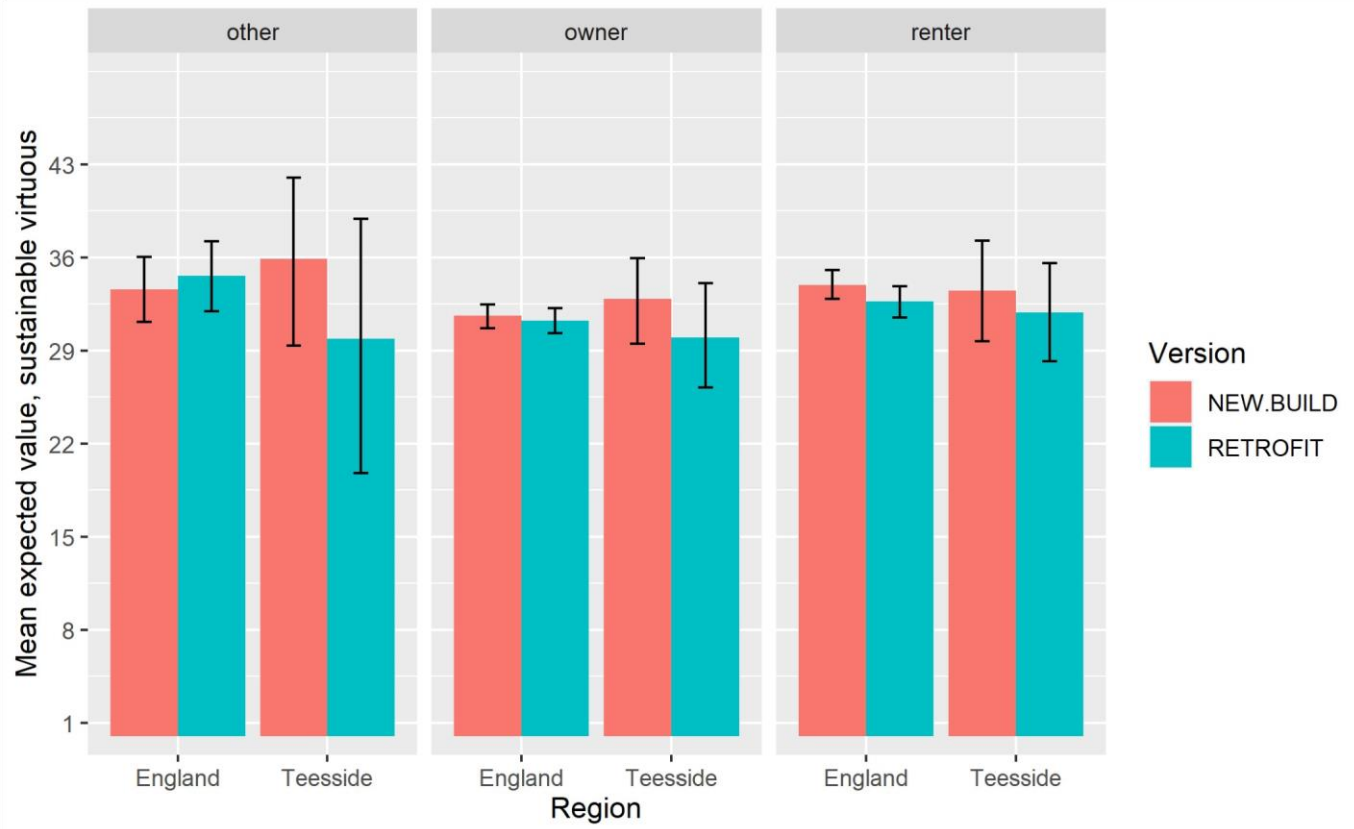
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean expected value, sustainable virtuous
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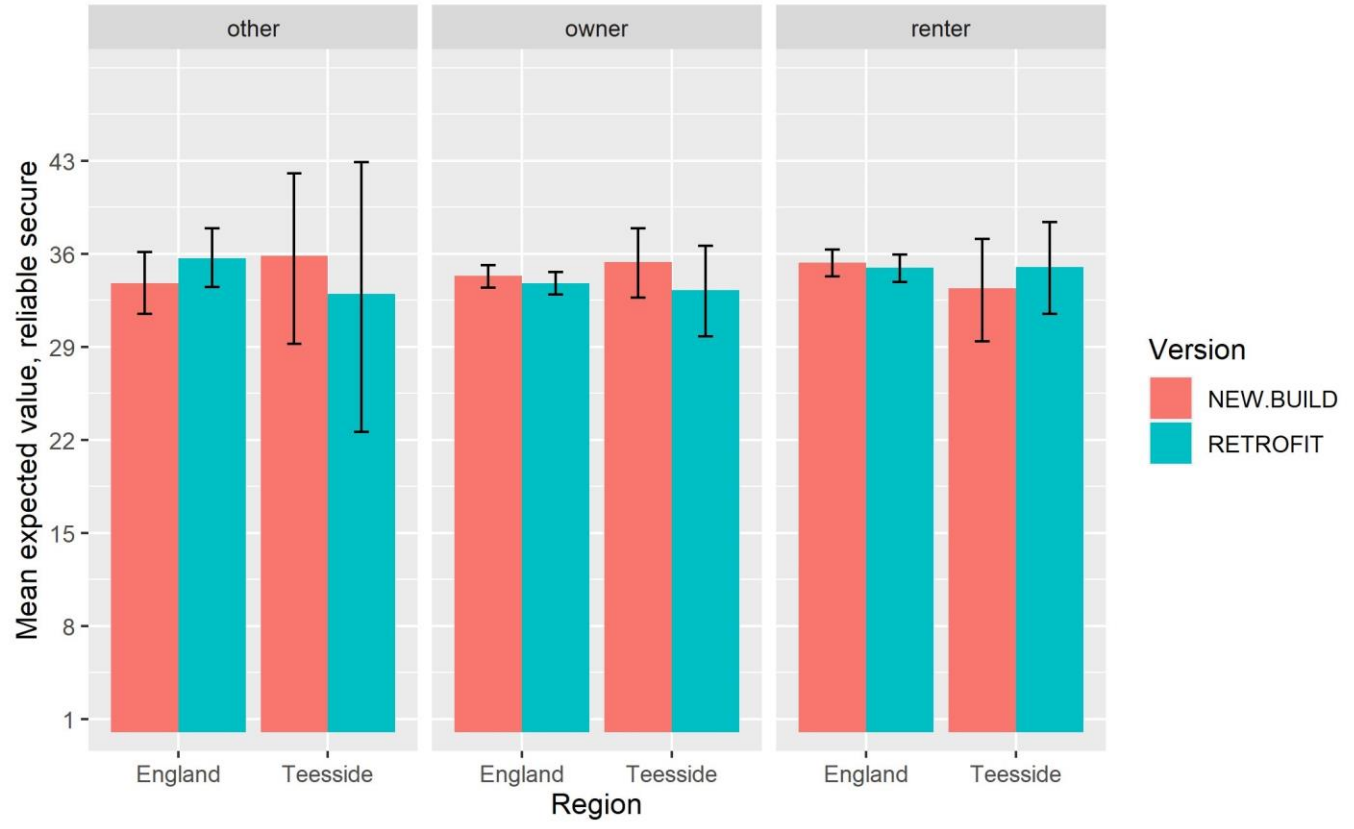
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean expected value, reliable secure
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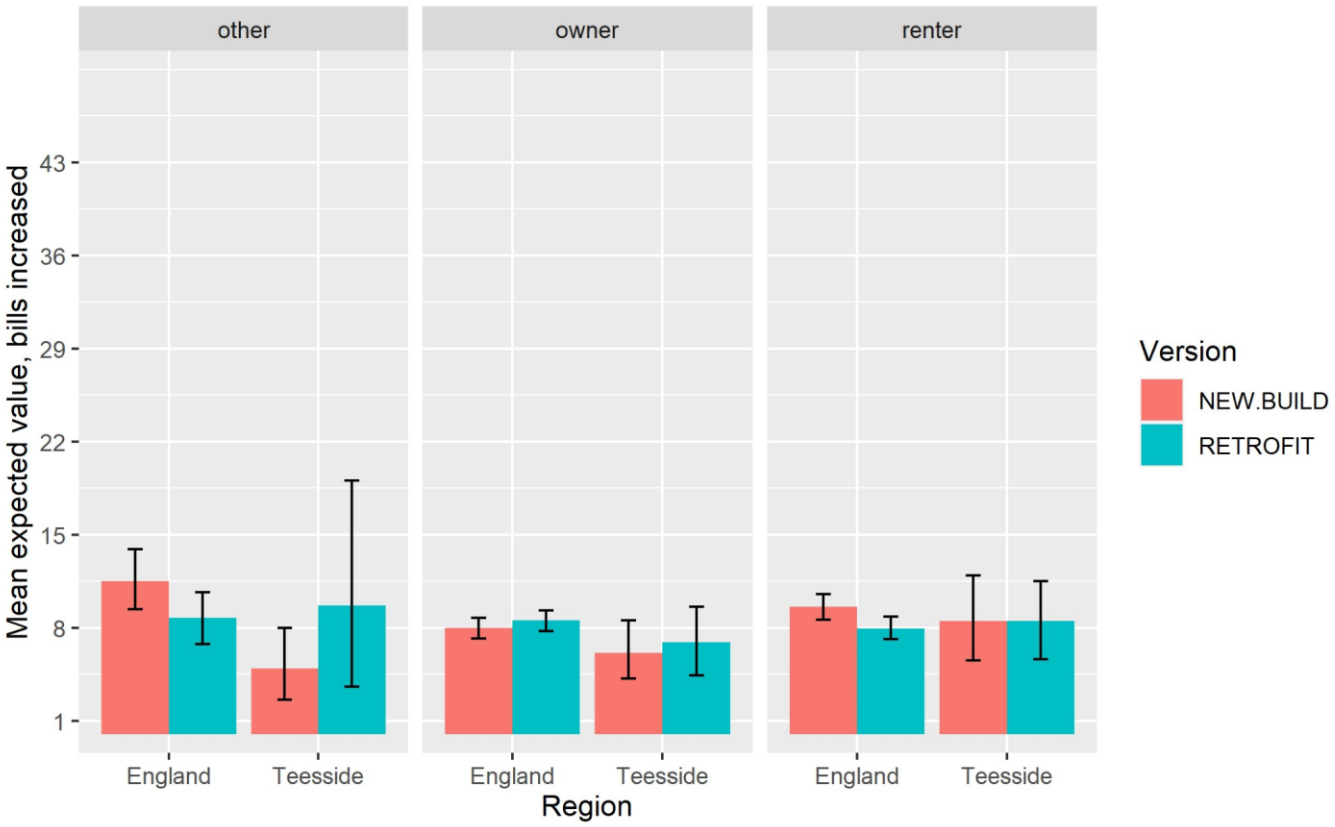
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean expected value, bills increased
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36
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22
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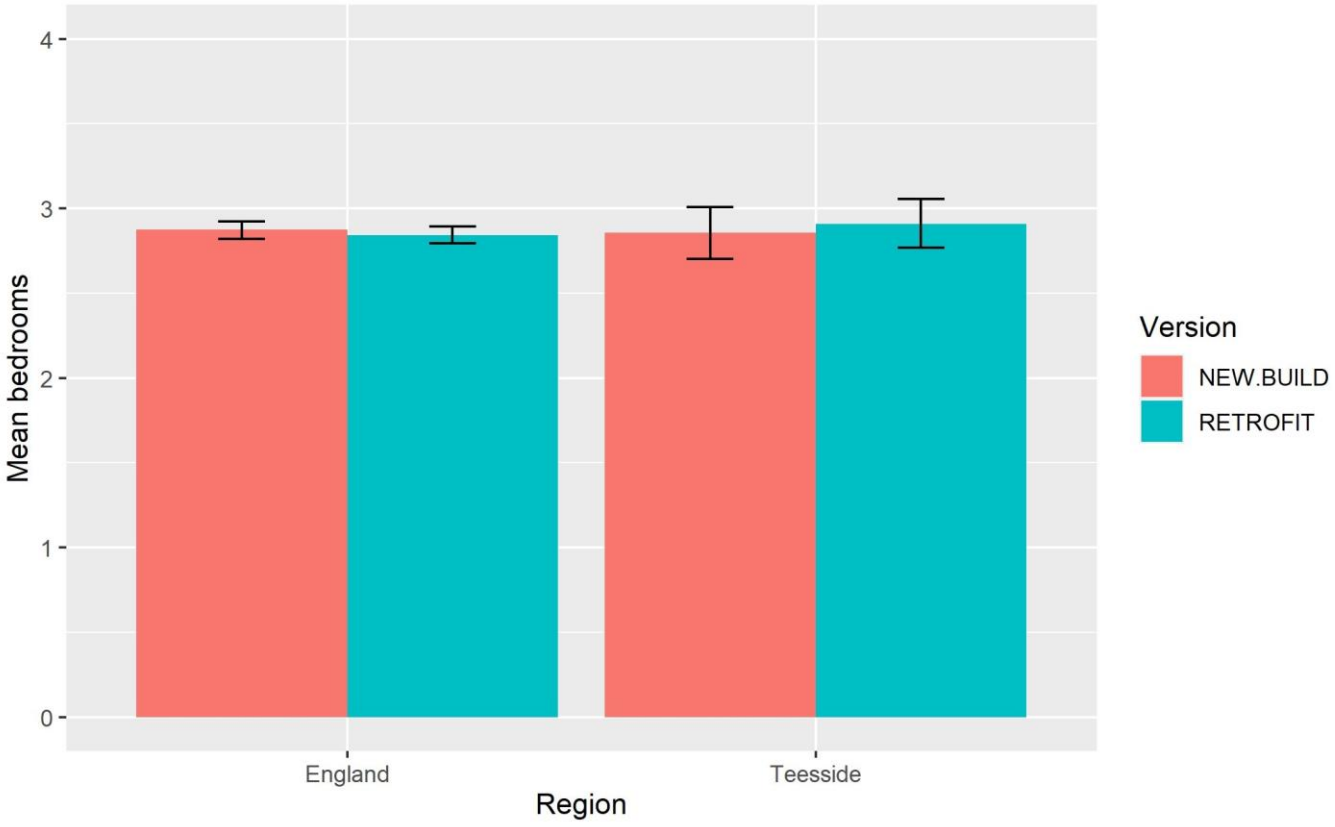
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


Mean bedrooms
4
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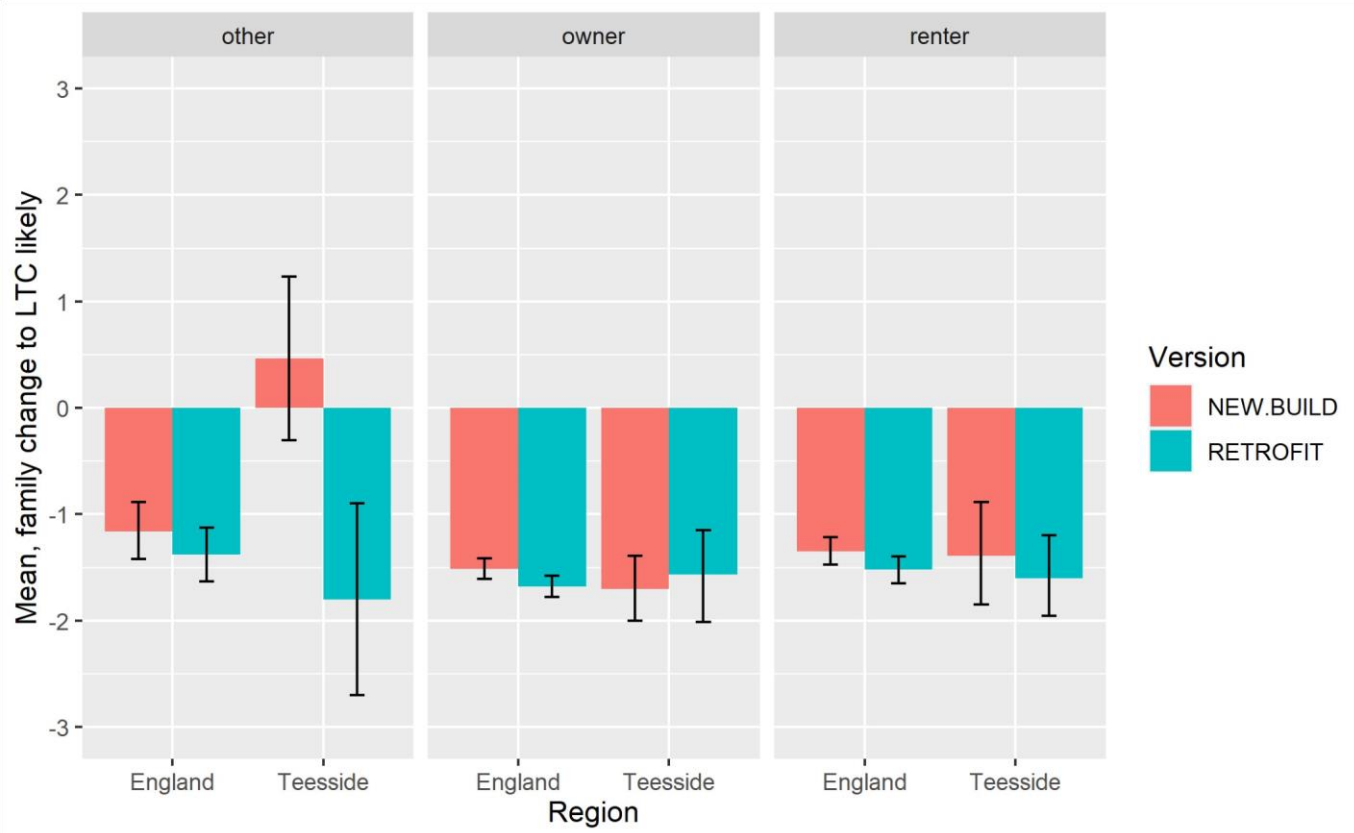
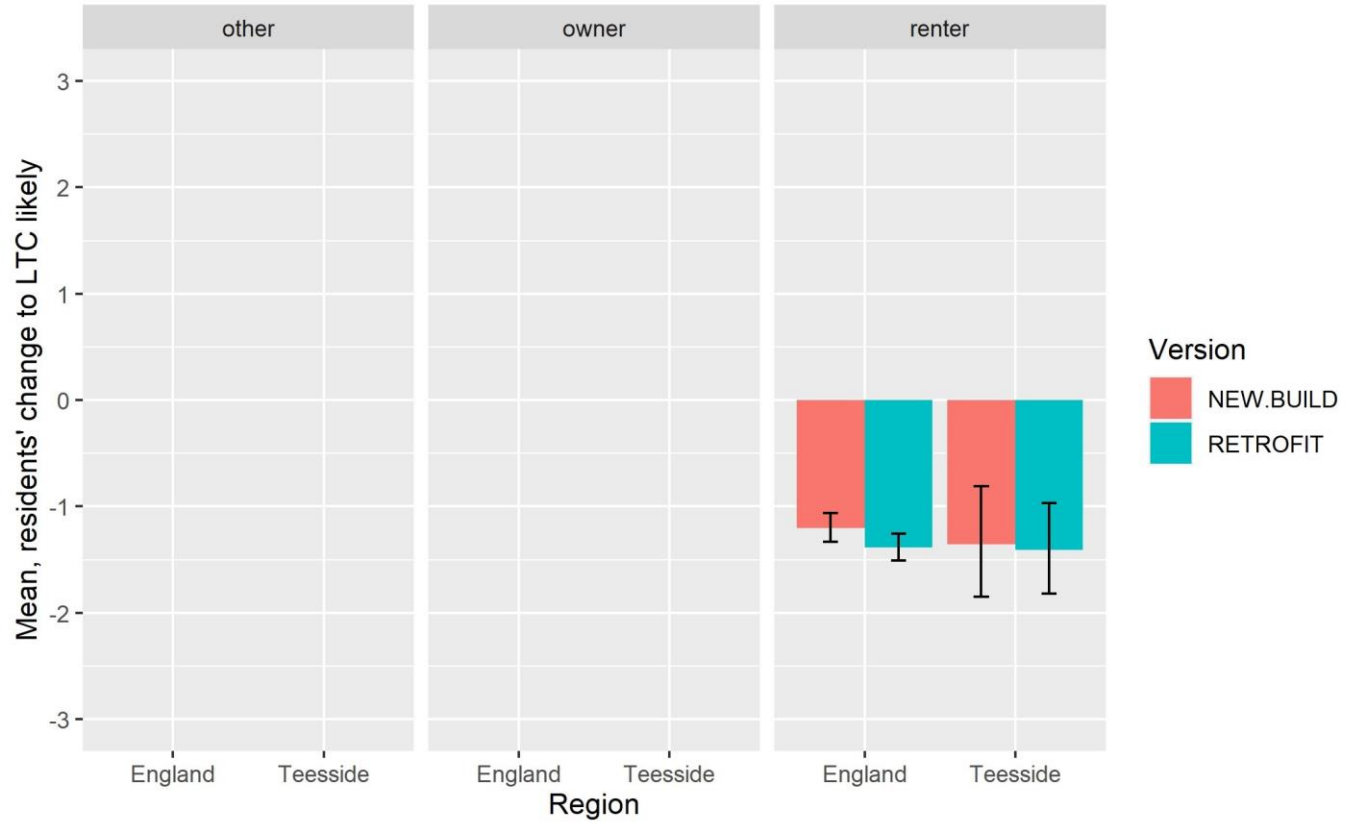
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean, family change to LTC likely
3
2
1
0
-1
-2
-3
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean, residents' change to LTC likely
3
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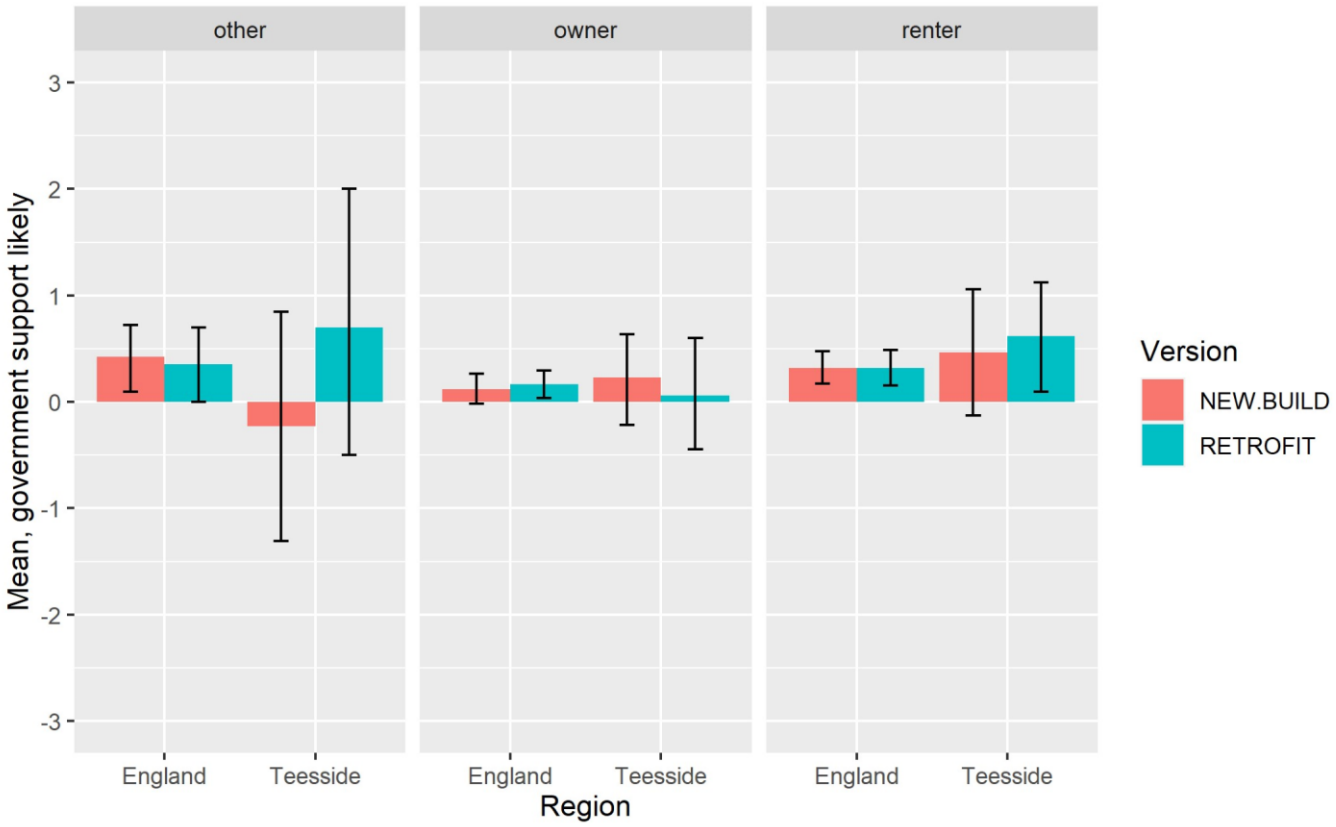
1
0
-1
-2
-3
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean, government support likely
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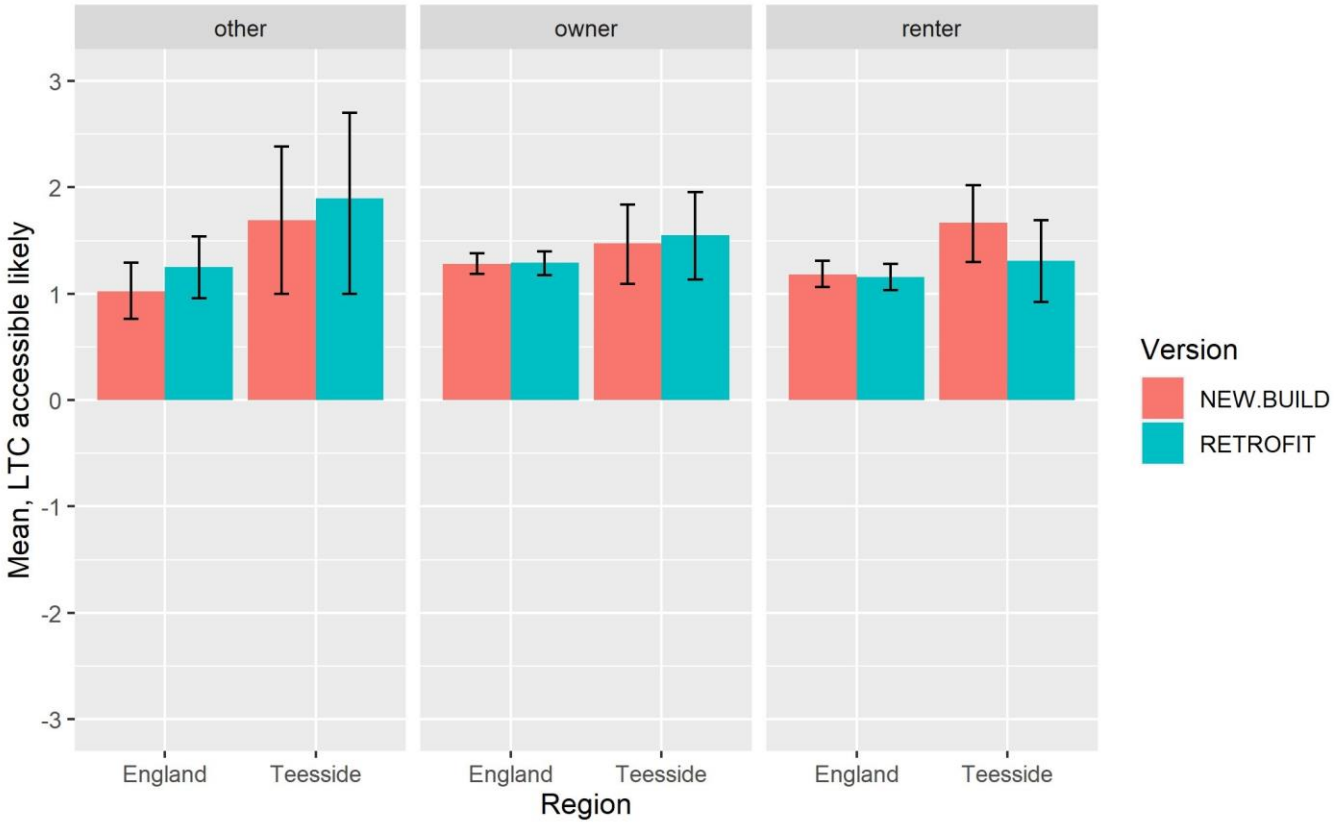
1
0
-1
-2
-3
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean, LTC accessible likely
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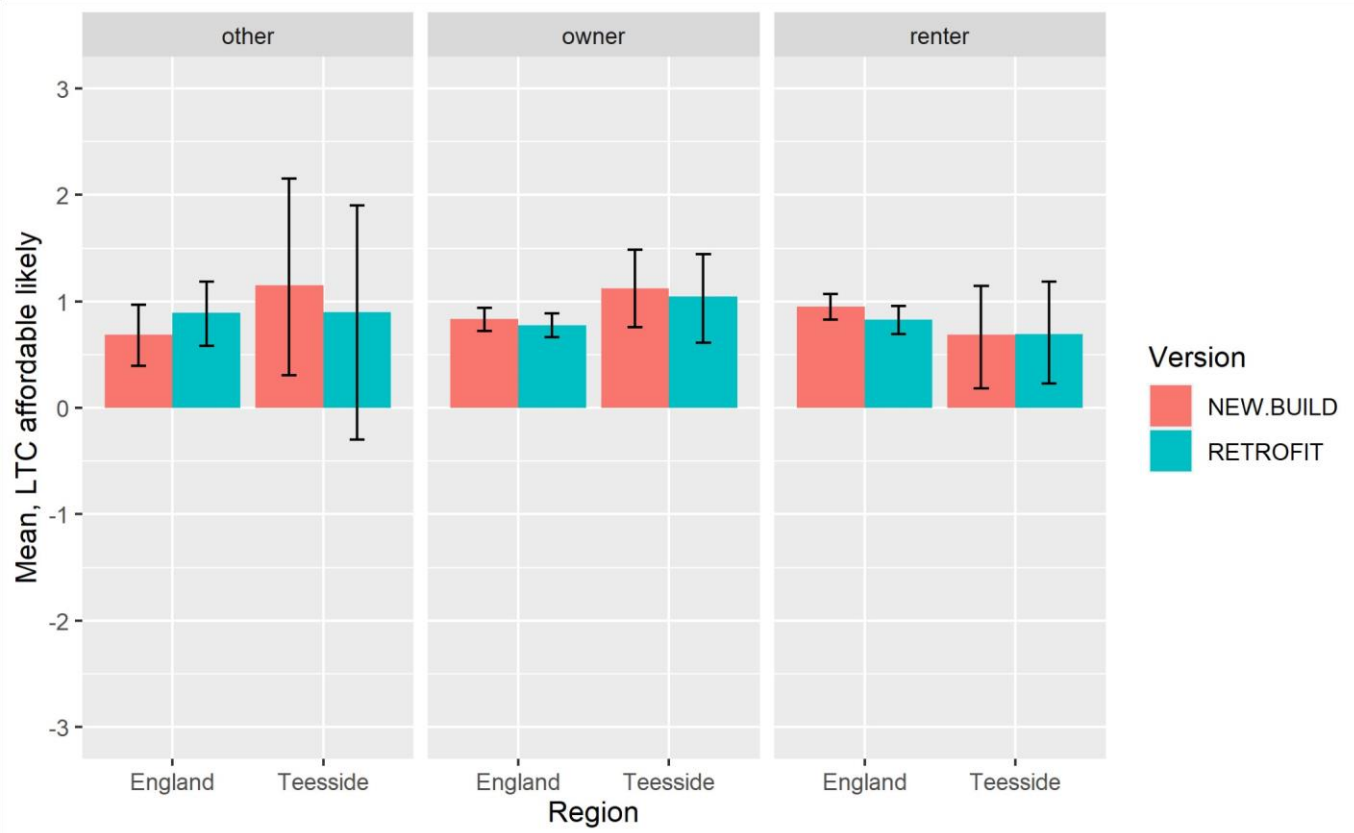
-2
-3
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean, LTC affordable likely
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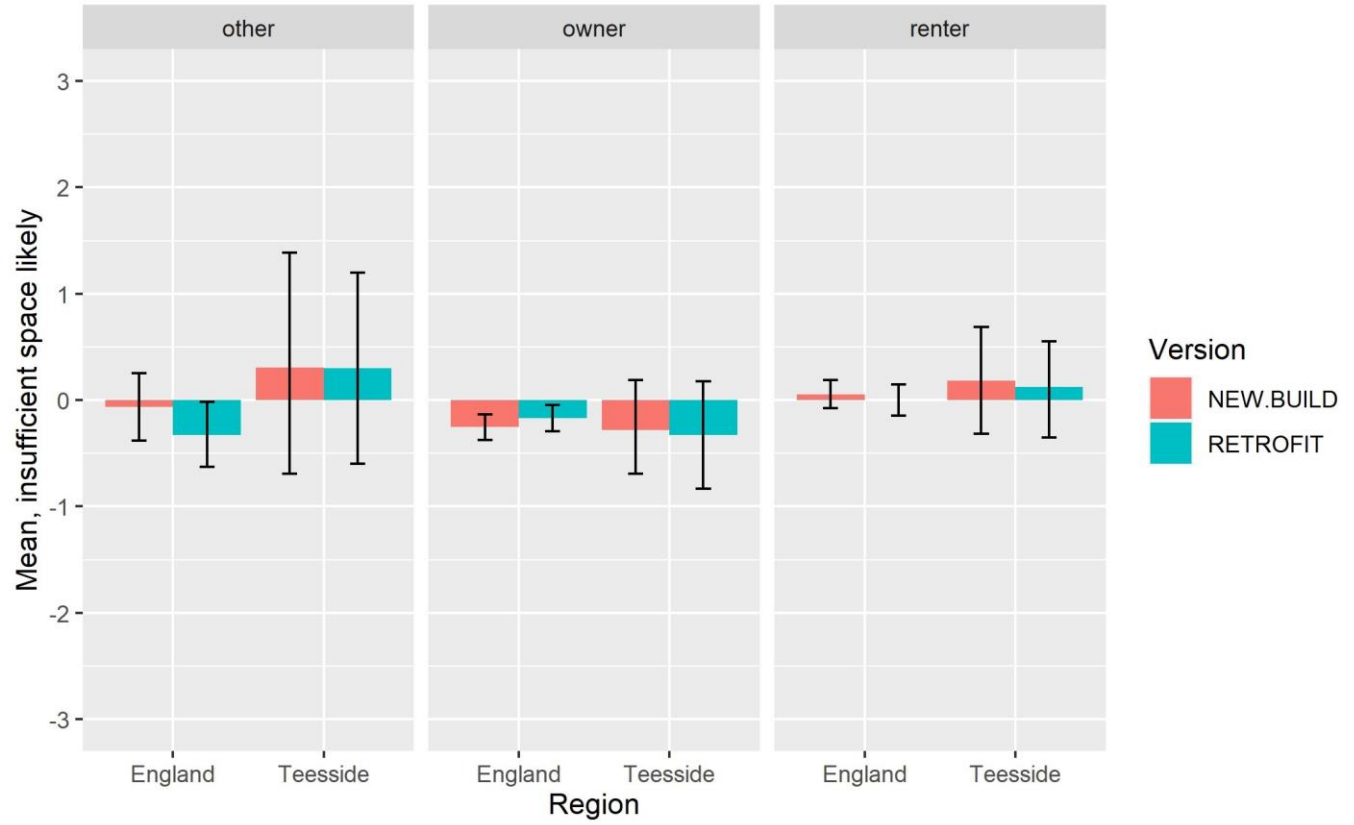
-1
-2
-3
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean, insufficient space likely
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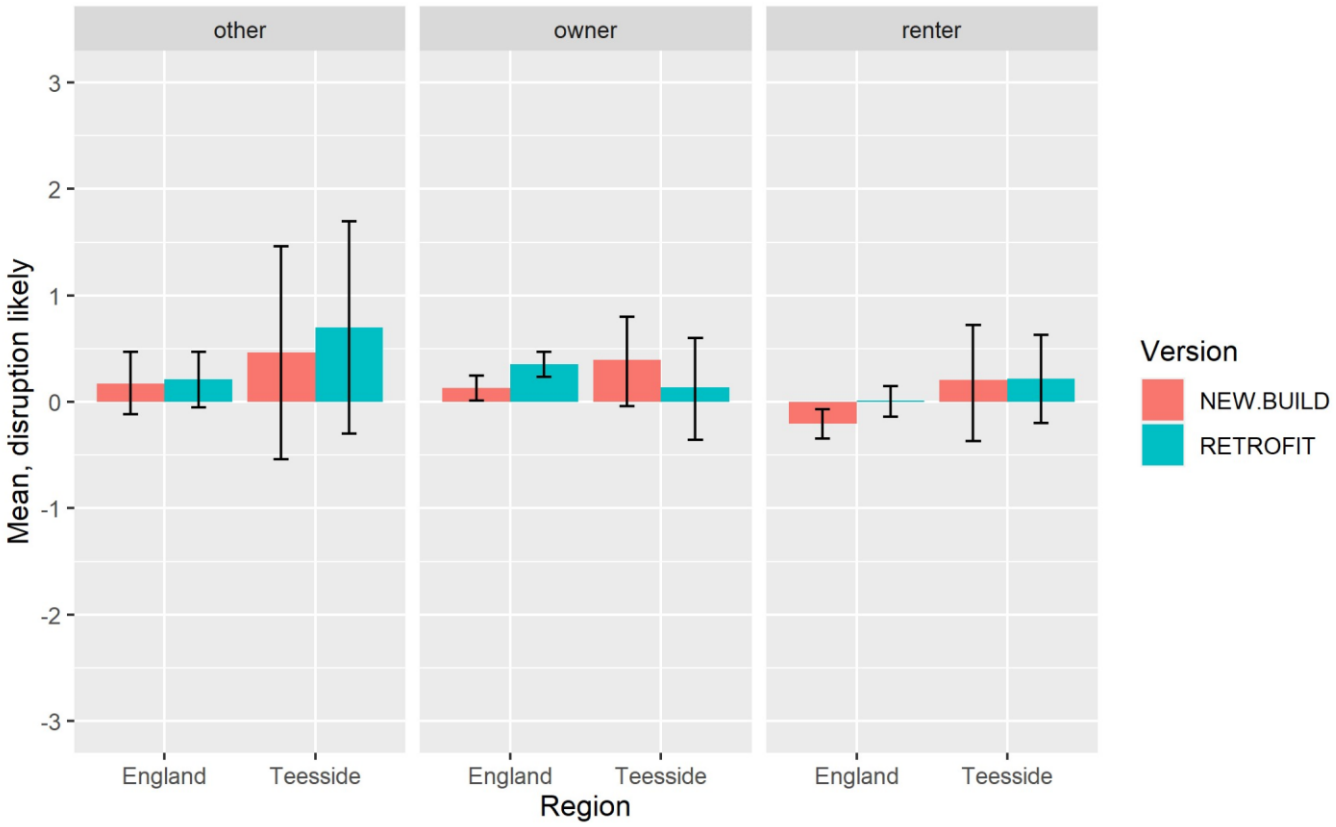
2
1
0
-1
-2
-3
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean, disruption likely
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2
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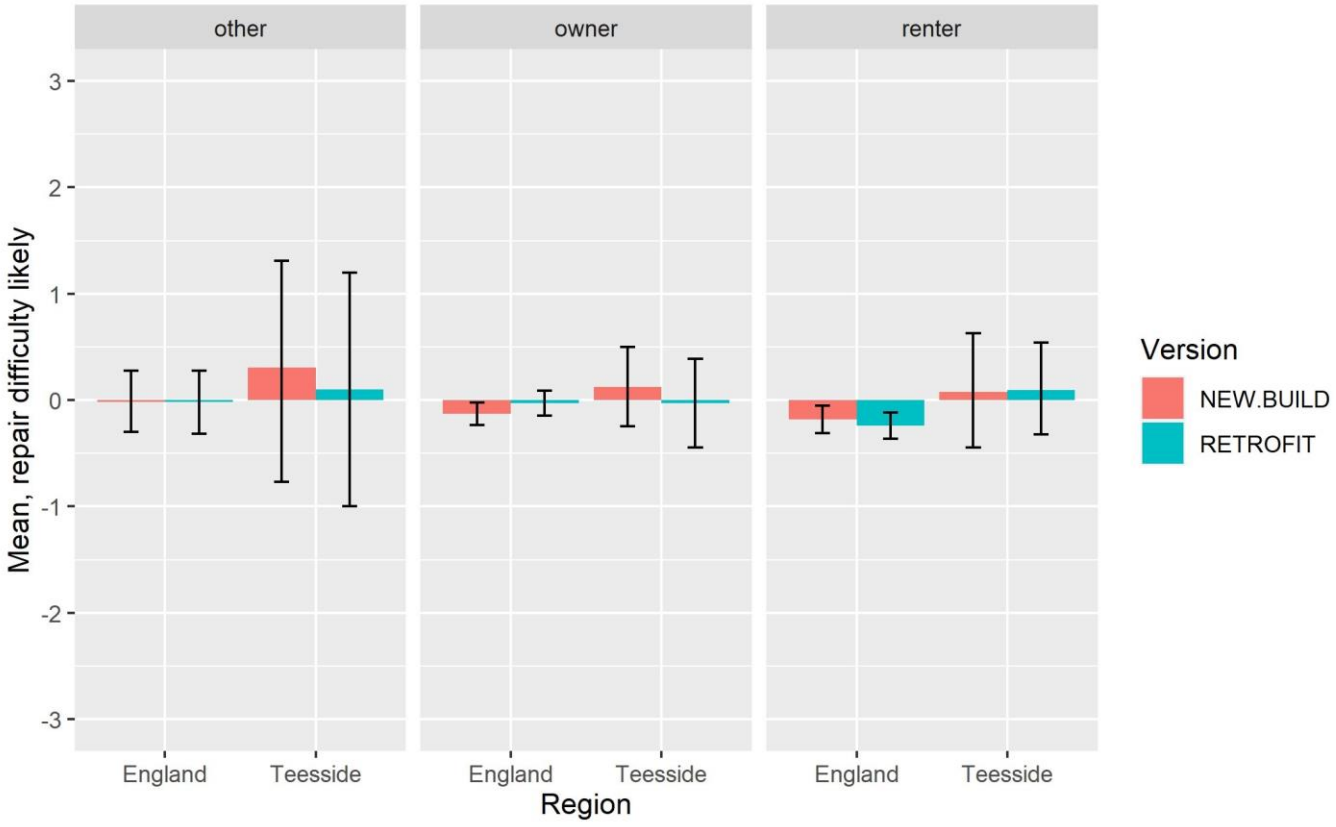
-1
-2
-3
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean, repair difficulty likely
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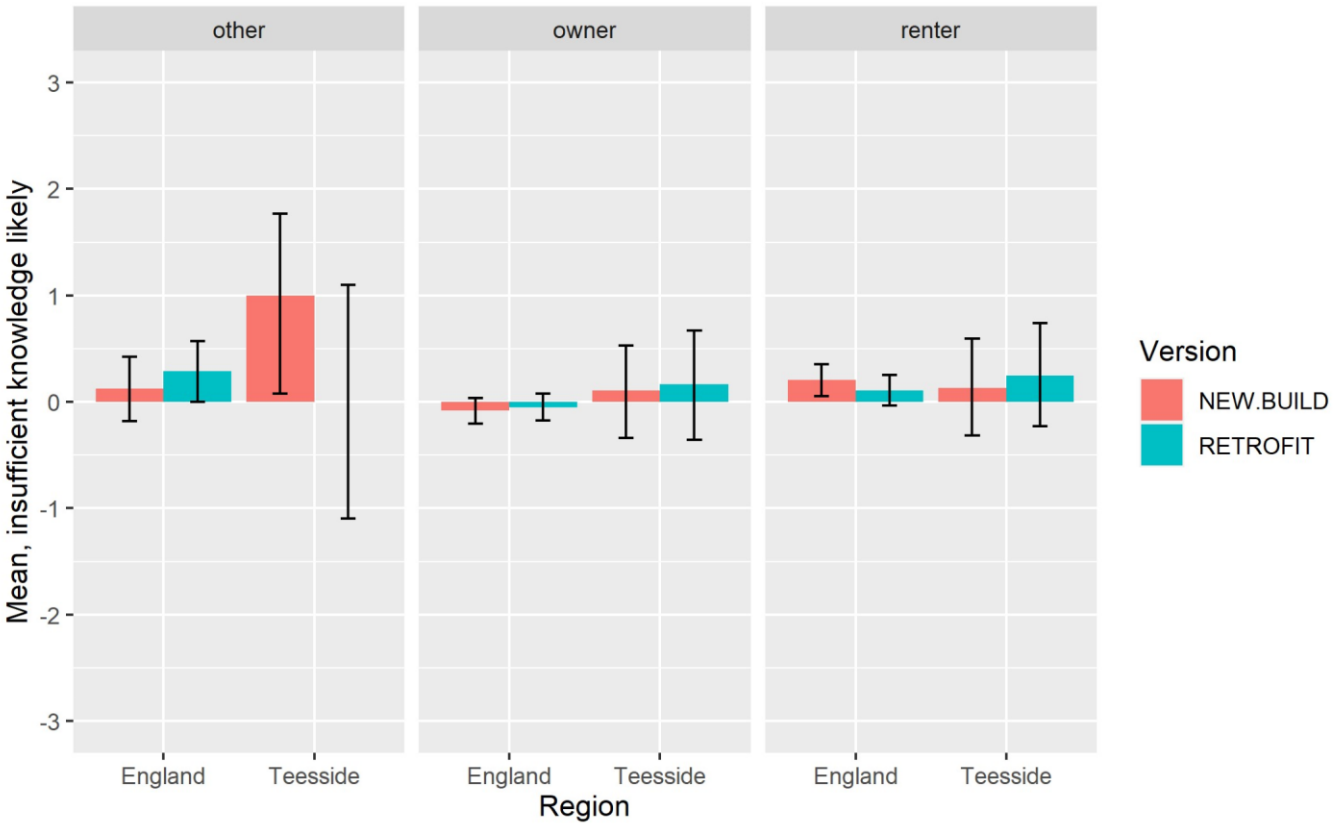
-1
-2
-3
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean, insufficient knowledge likely
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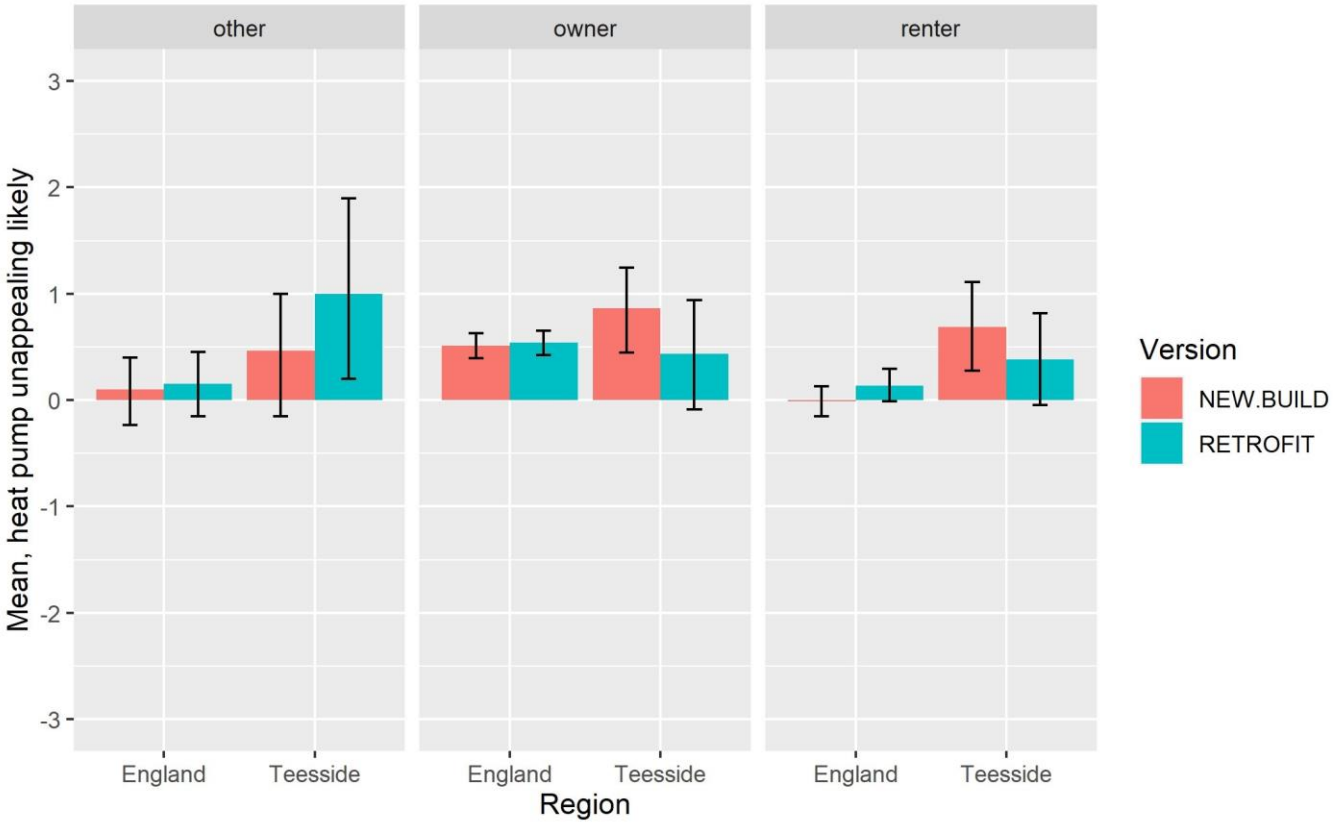
-1
-2
-3
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean, heat pump unappealing likely
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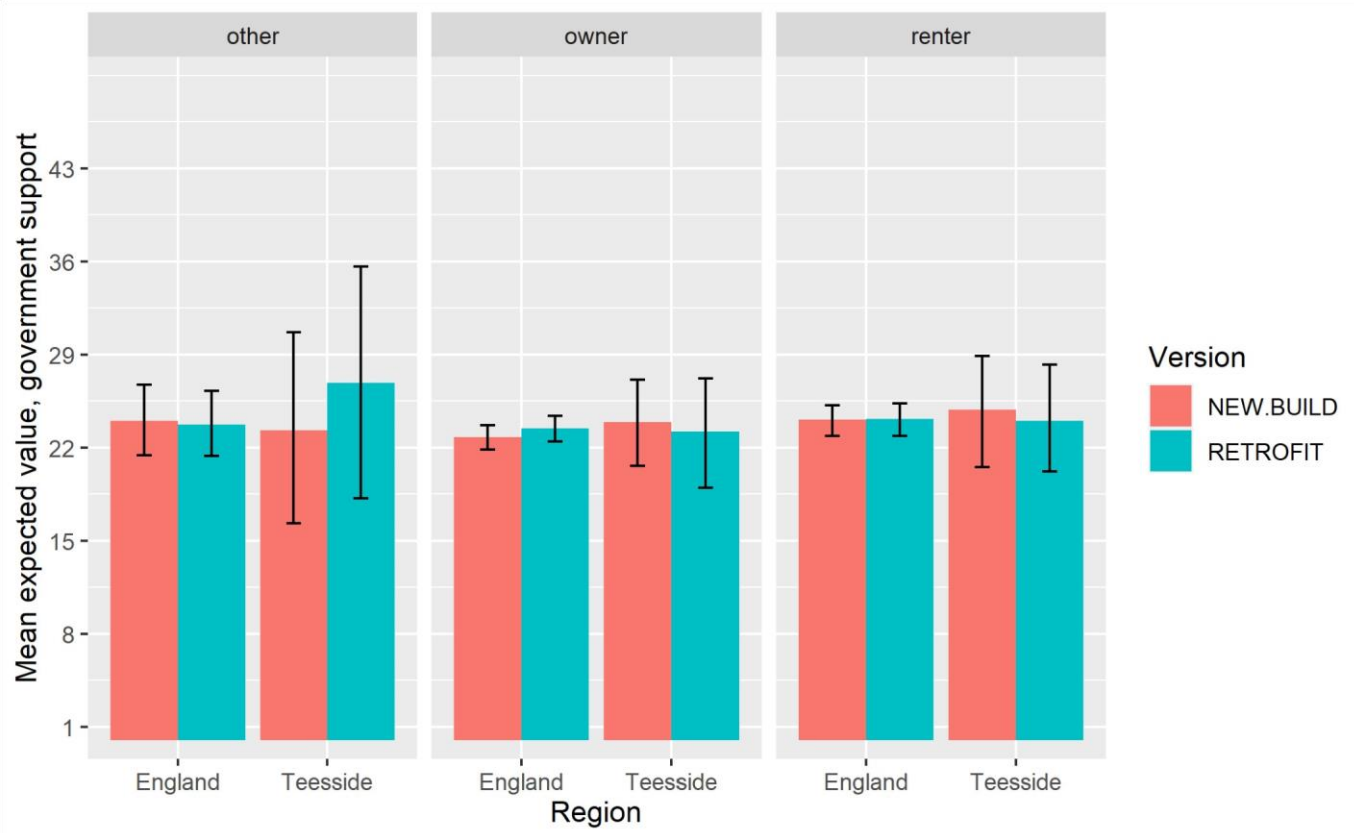
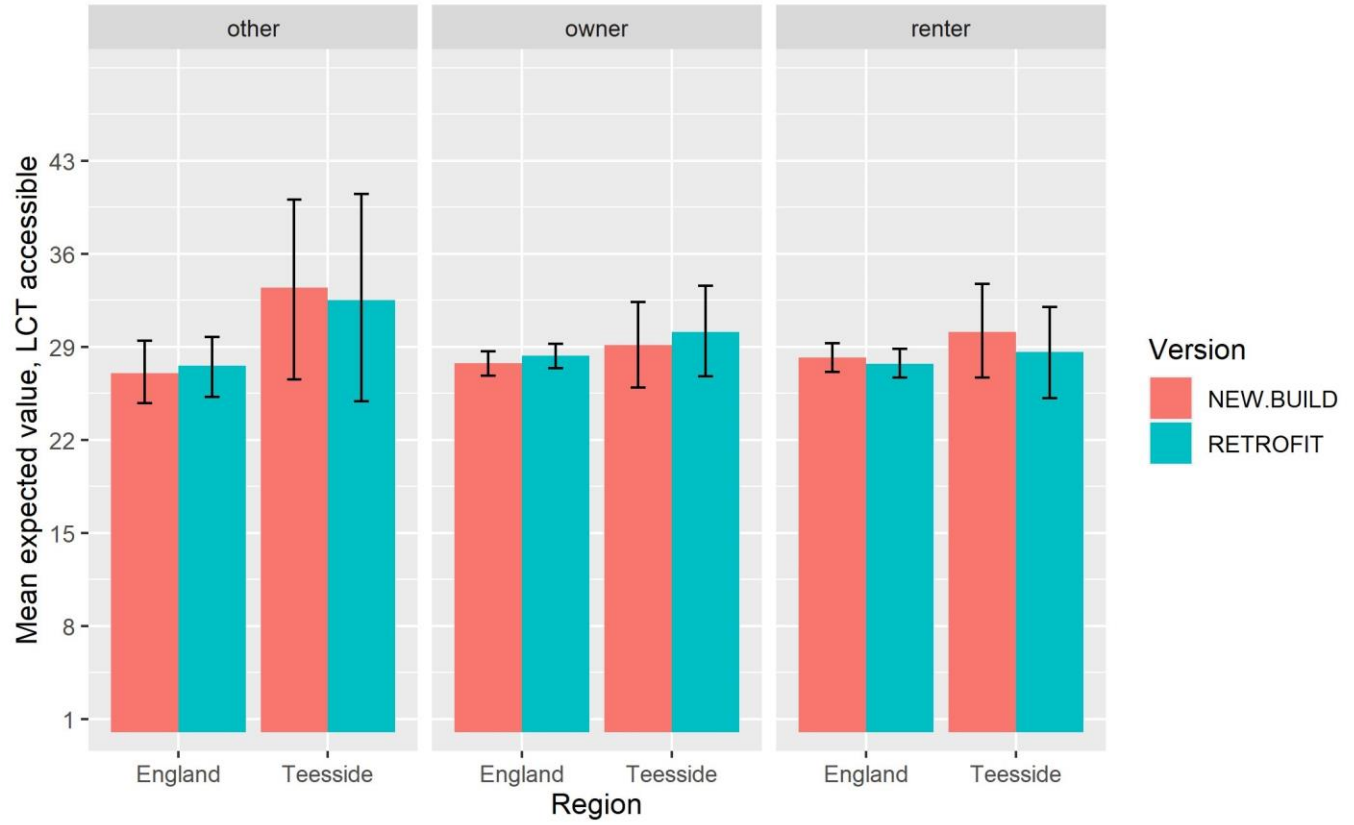
-1
-2
-3
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean expected value, government support
43
36
29
22
15
8
1
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean expected value, LCT accessible
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22
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8
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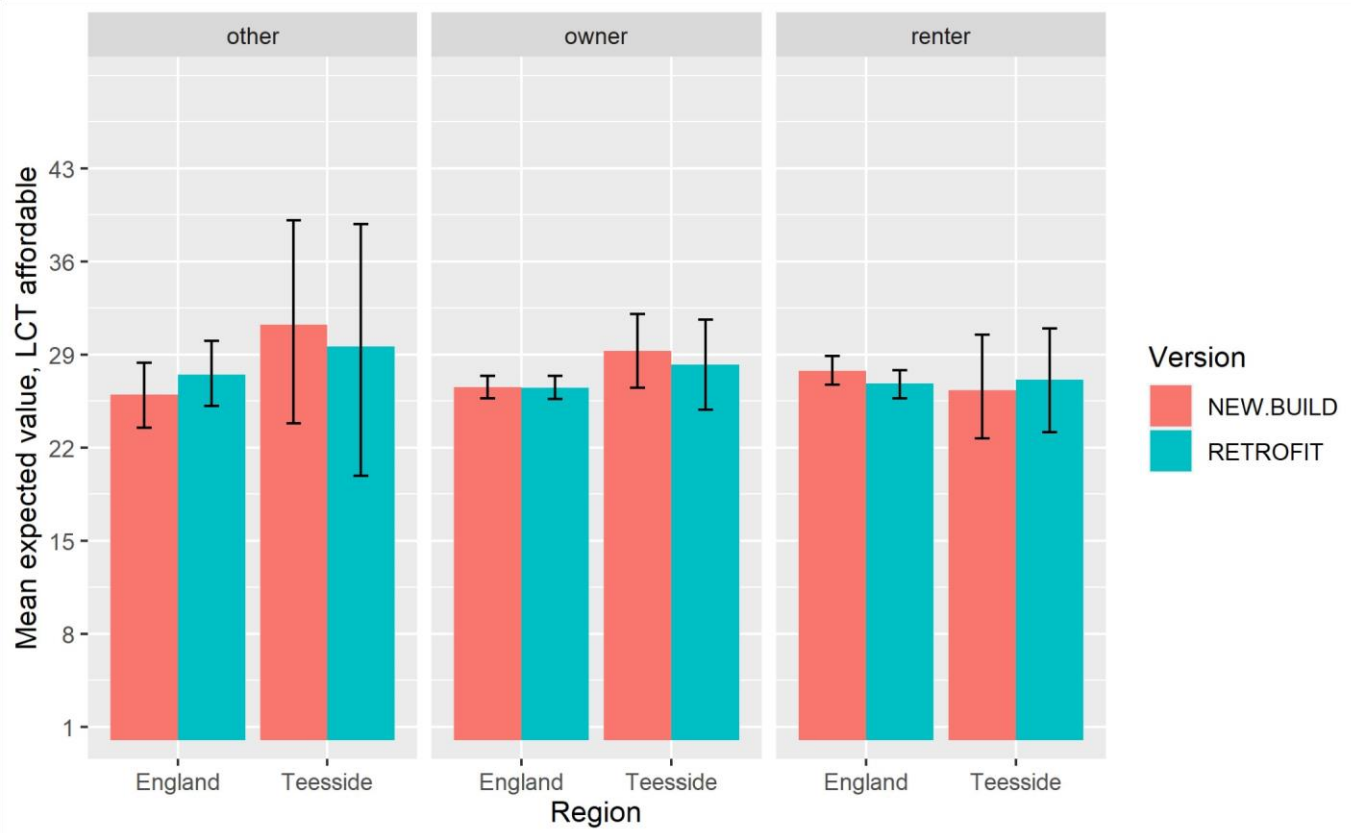
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean expected value, LCT affordable
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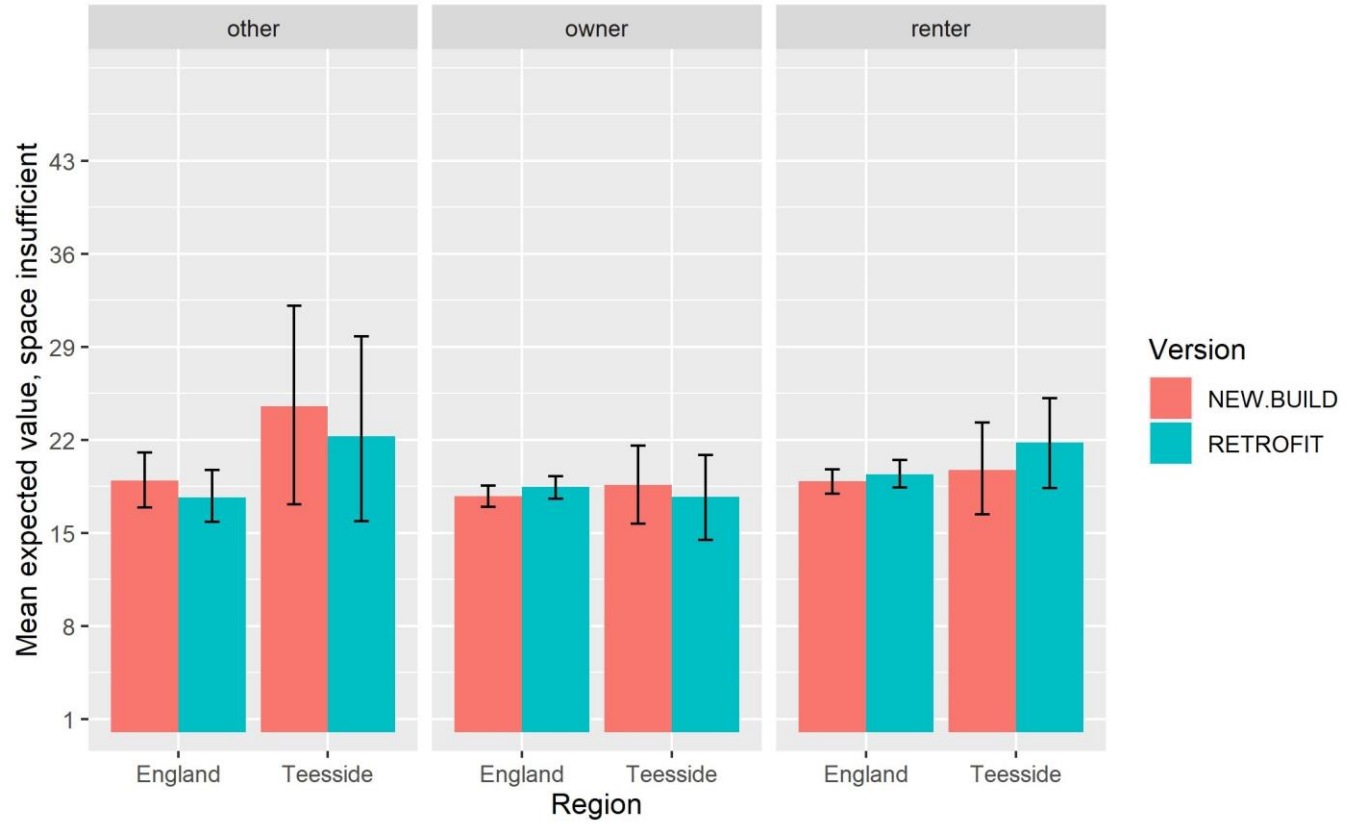
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean expected value, space insufficient
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36
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22
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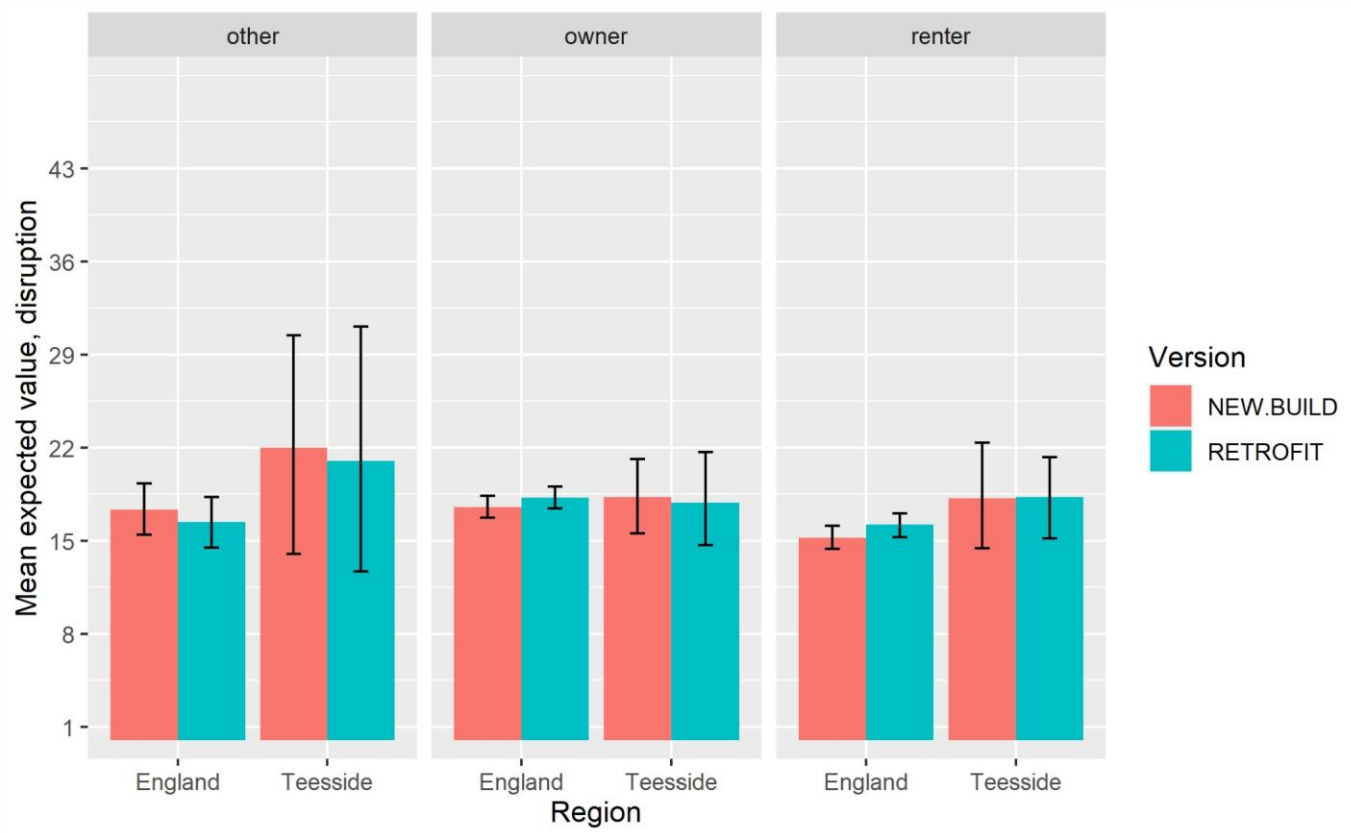
1
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean expected value, disruption
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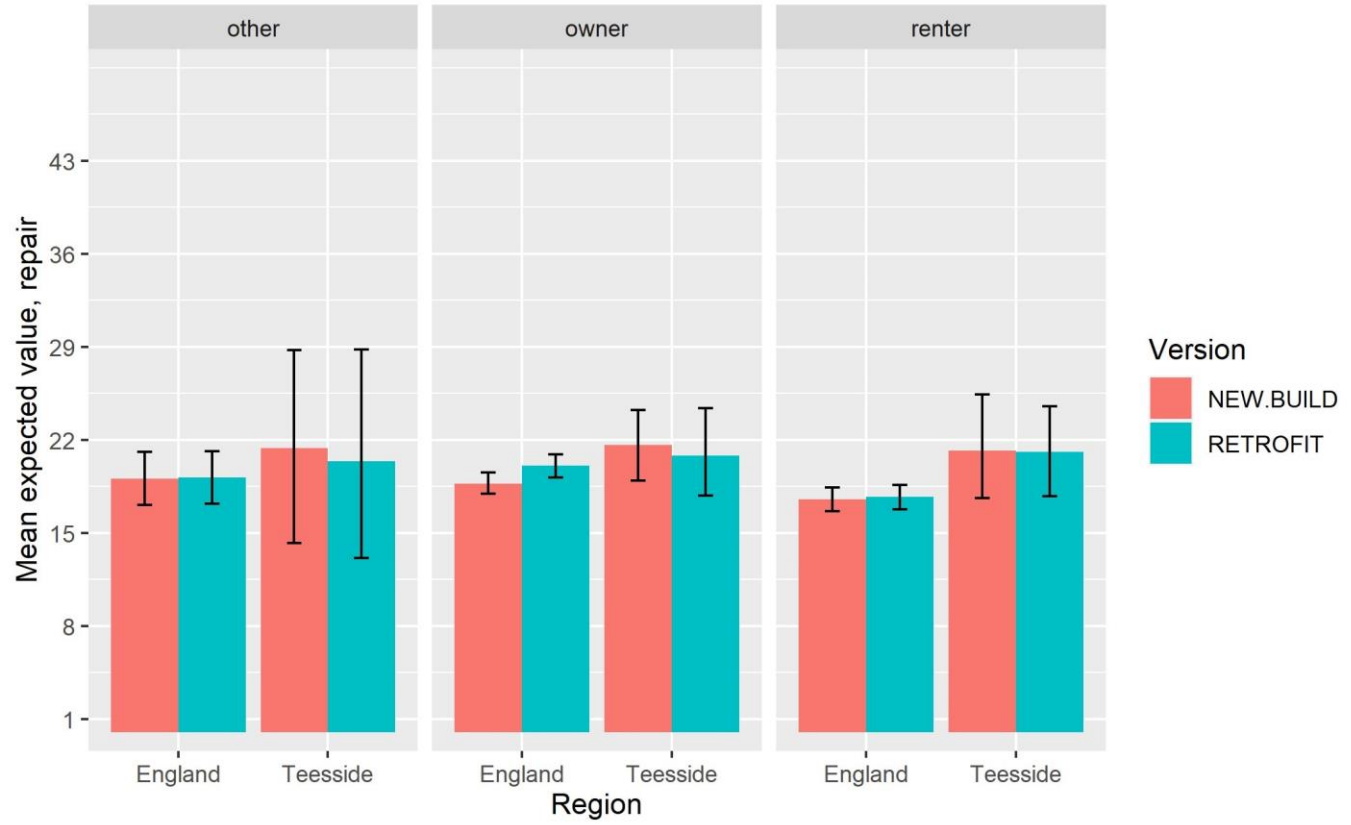
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean expected value, repair
43
36
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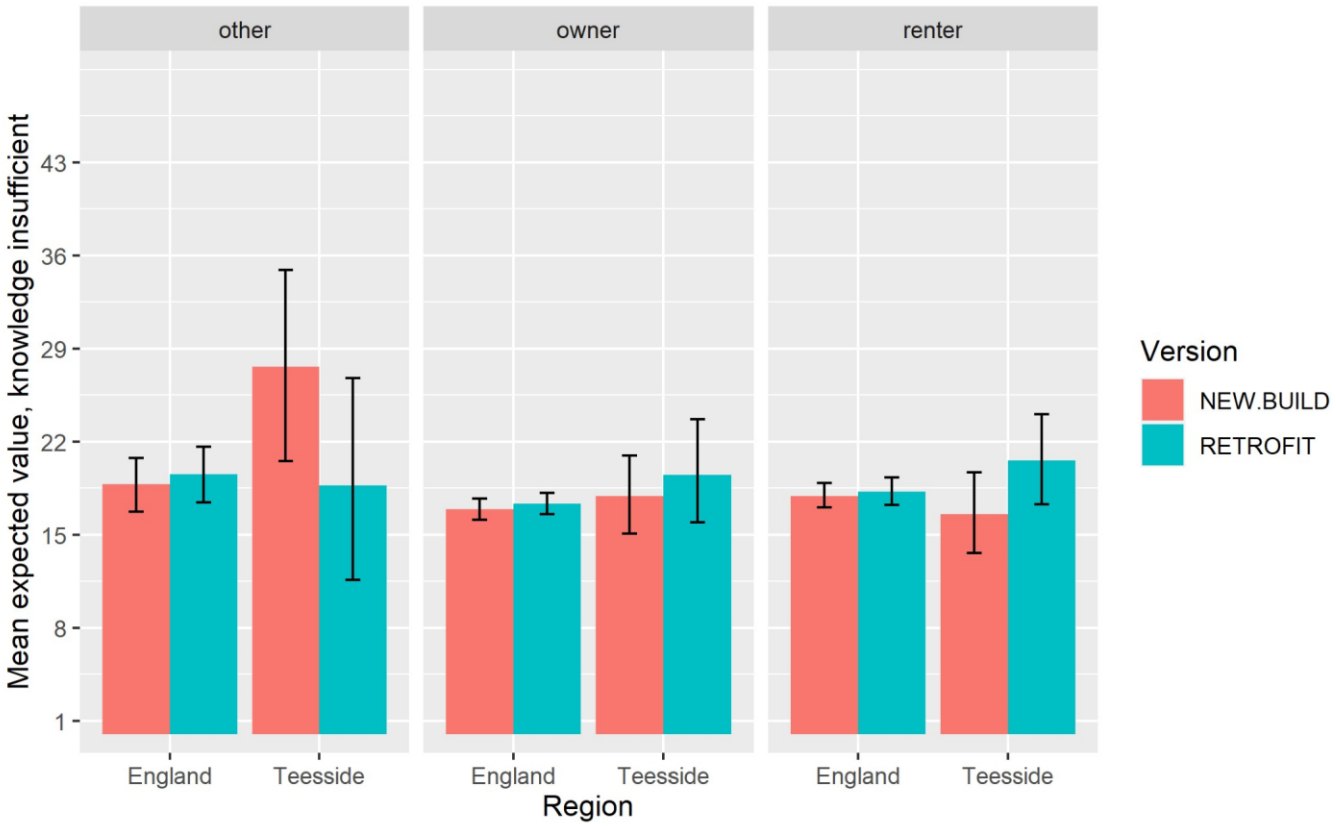
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean expected value, knowledge insufficient
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22
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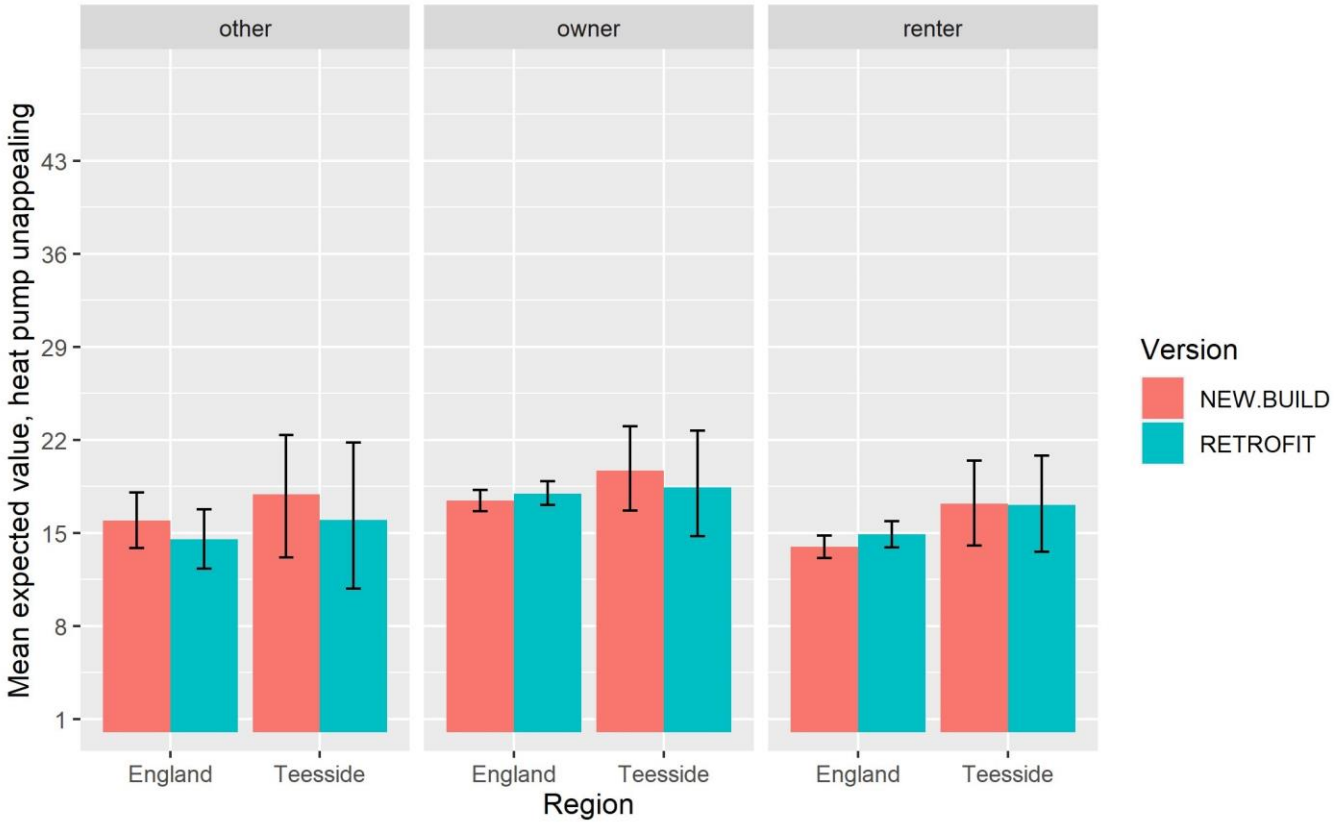
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean expected value, heat pump unappealing
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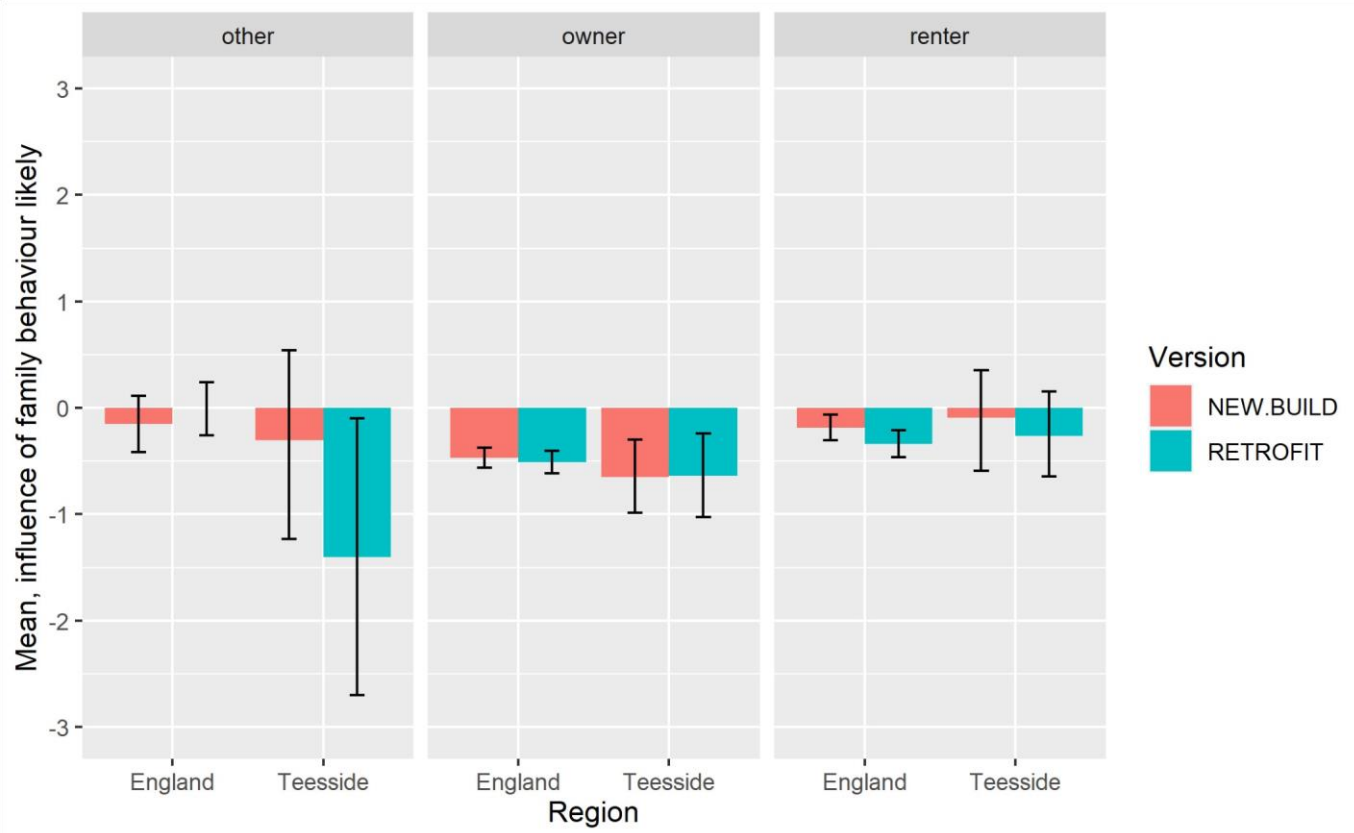
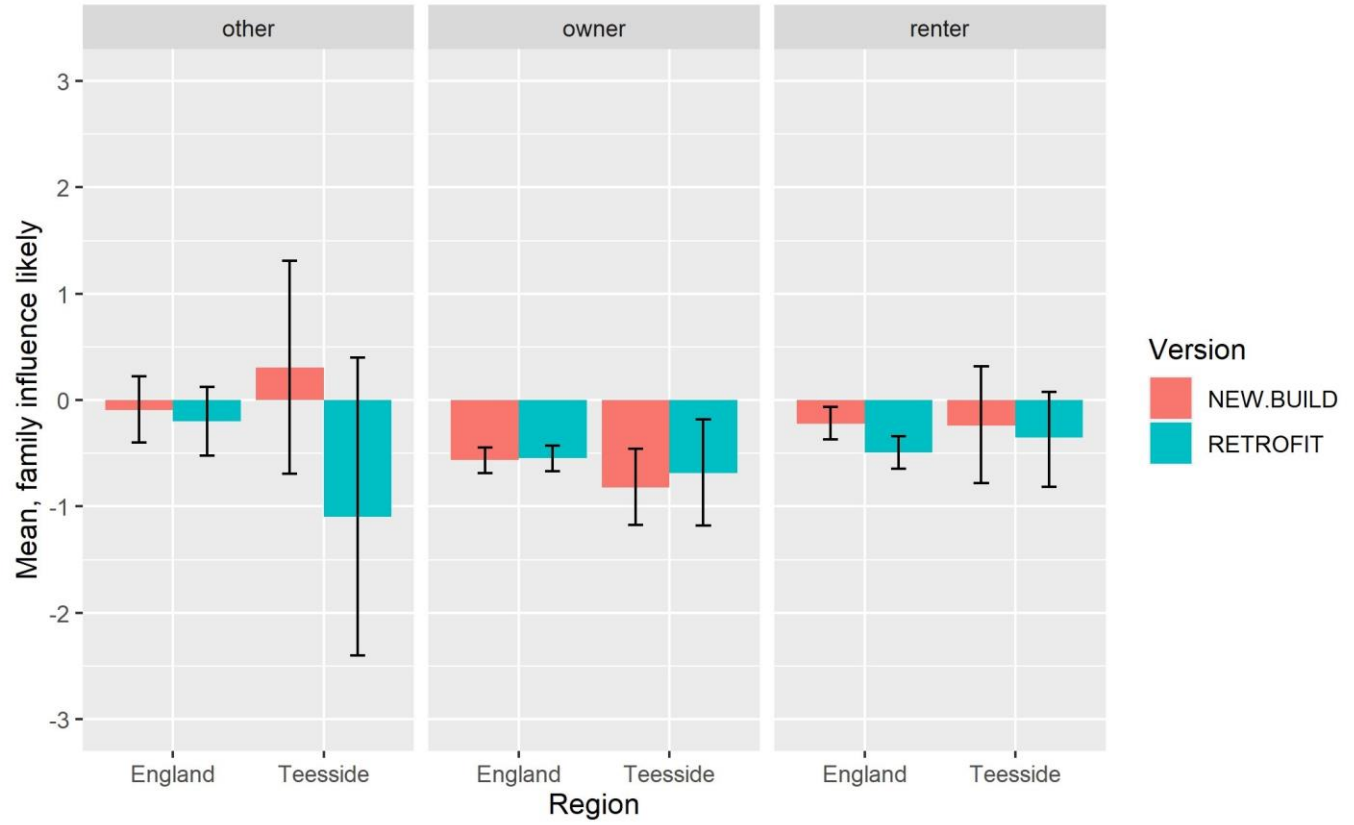
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean, influence of family behaviour likely
3
2
1
0
-1
-2
-3
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean, family influence likely
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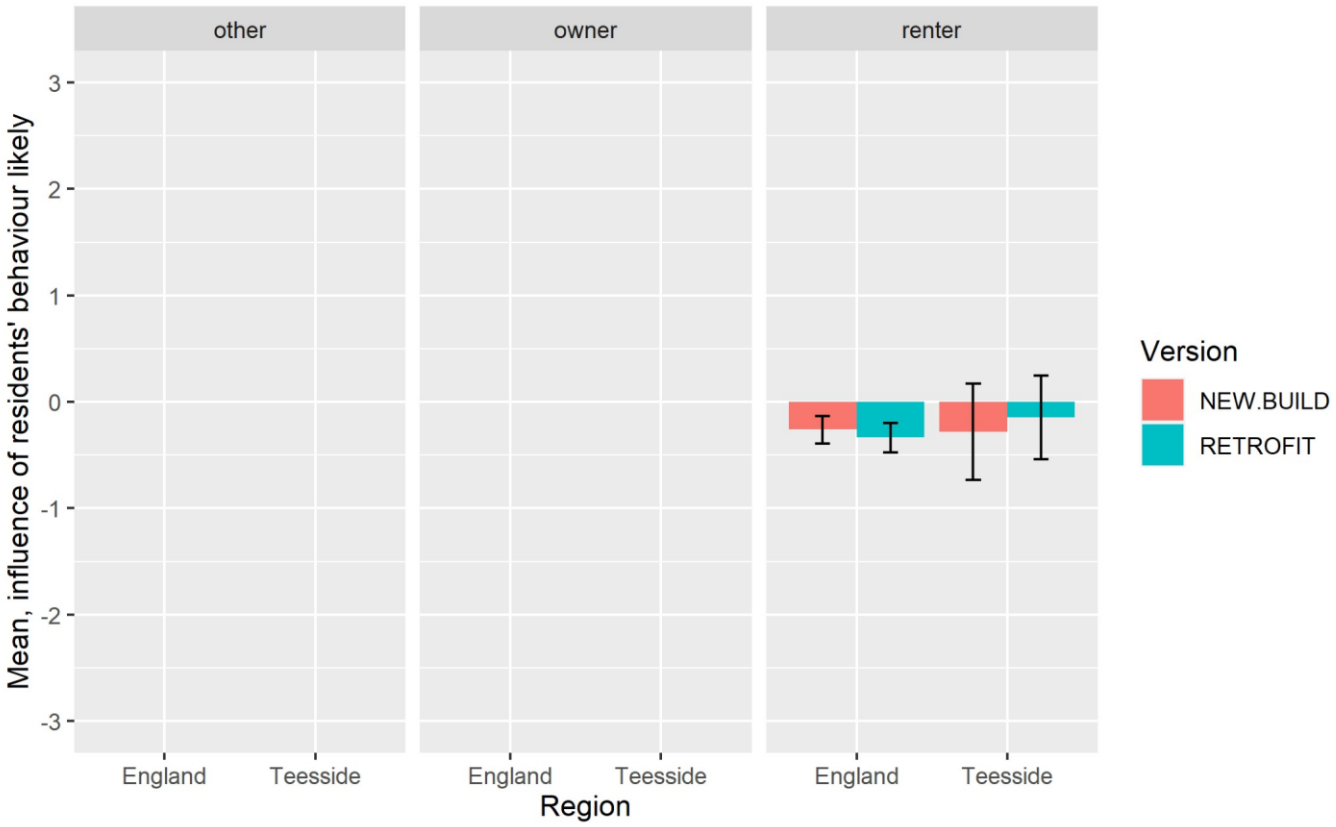
-2
-3
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean, influence of residents' behaviour likely
3
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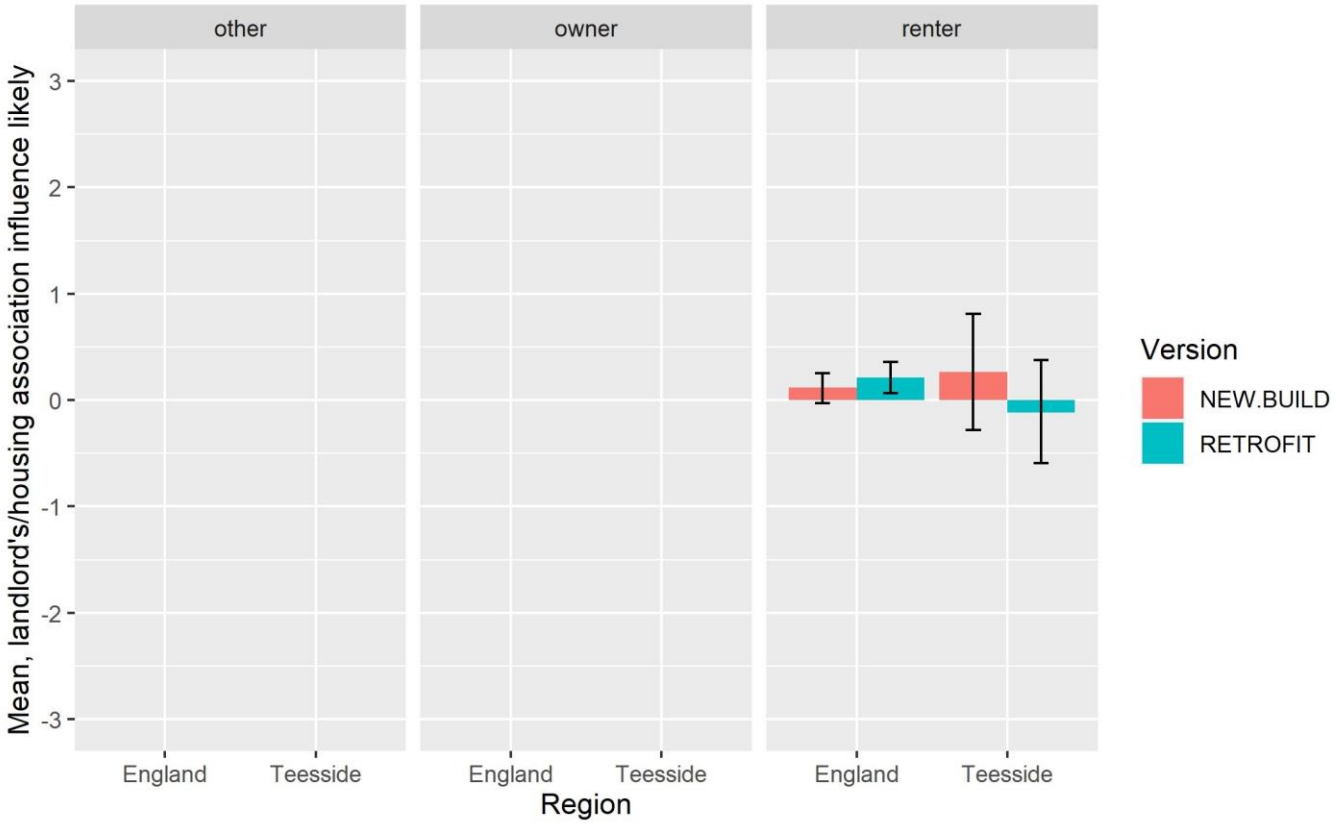
-2
-3
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean, landlord's/housing association influence likely
3
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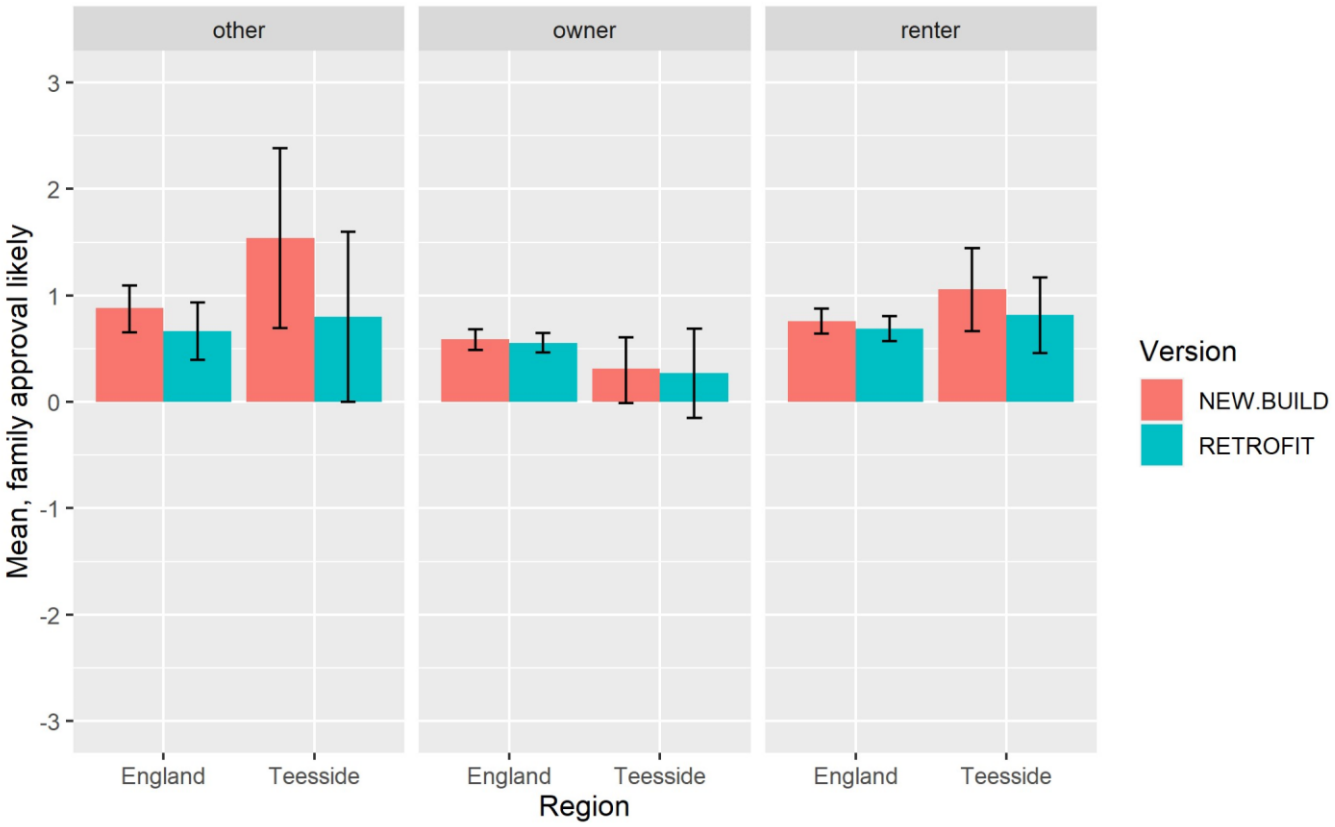
0
-1
-2
-3
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean, family approval likely
3
2
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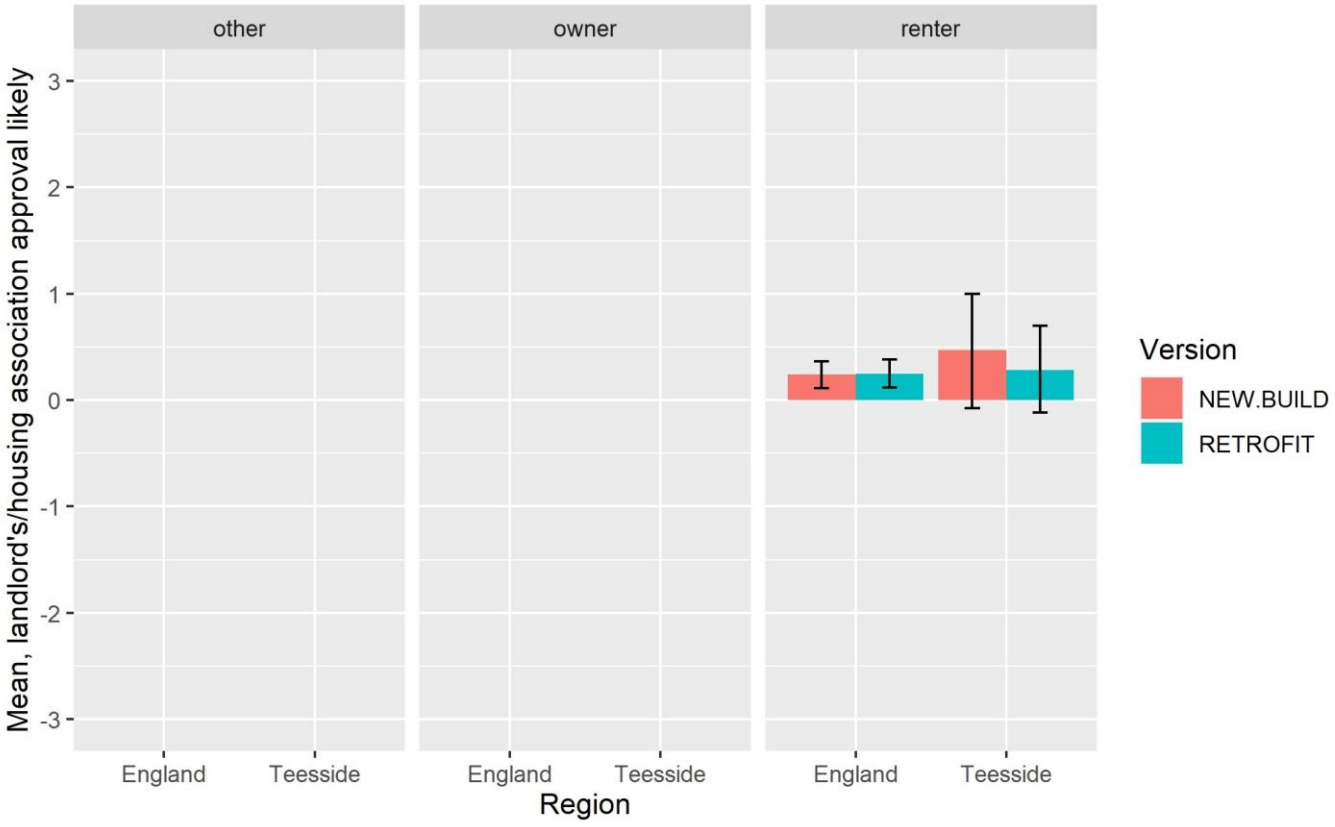
-1
-2
-3
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean, landlord's/housing association approval likely
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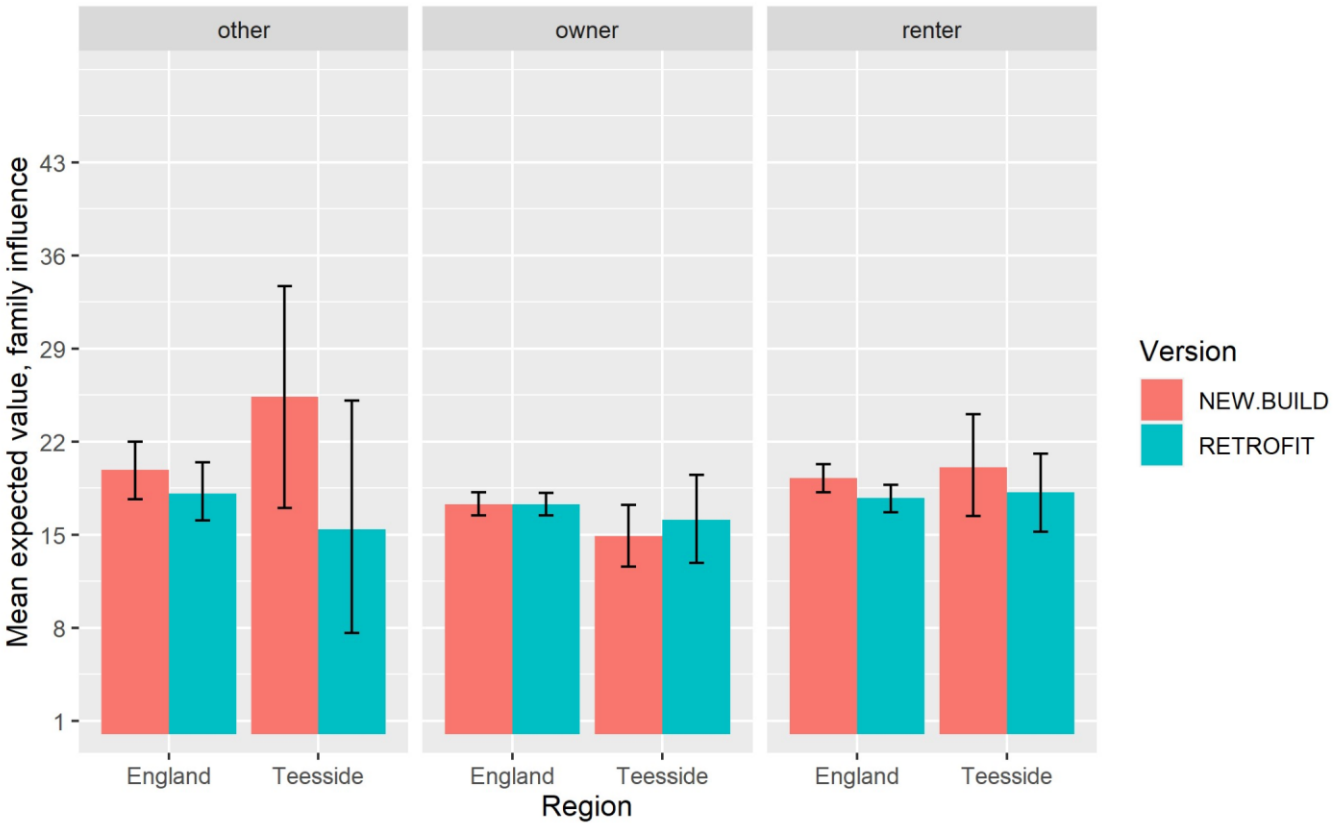
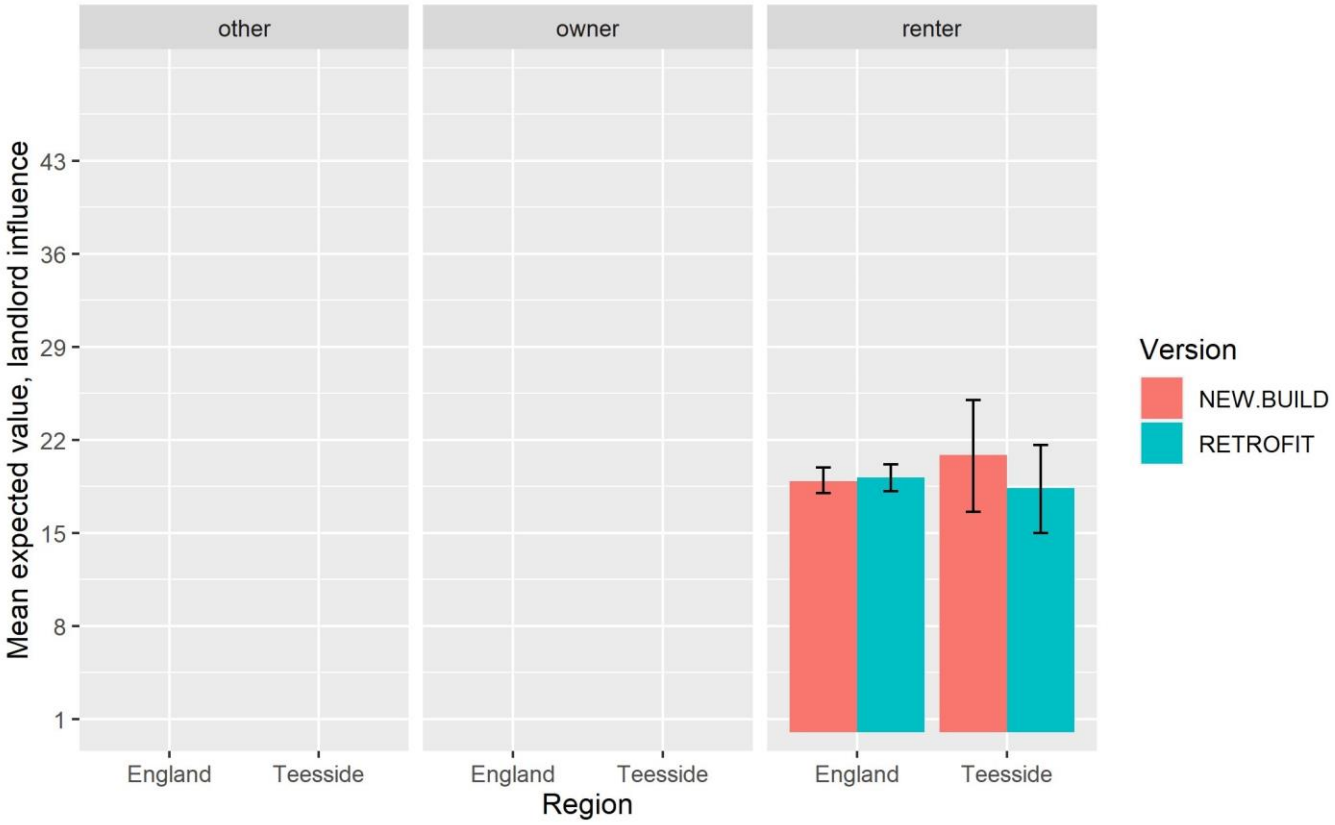
-2
-3
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean expected value, family influence
43
36
29
22
15
8
1
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean expected value, landlord influence
43
36
29
22
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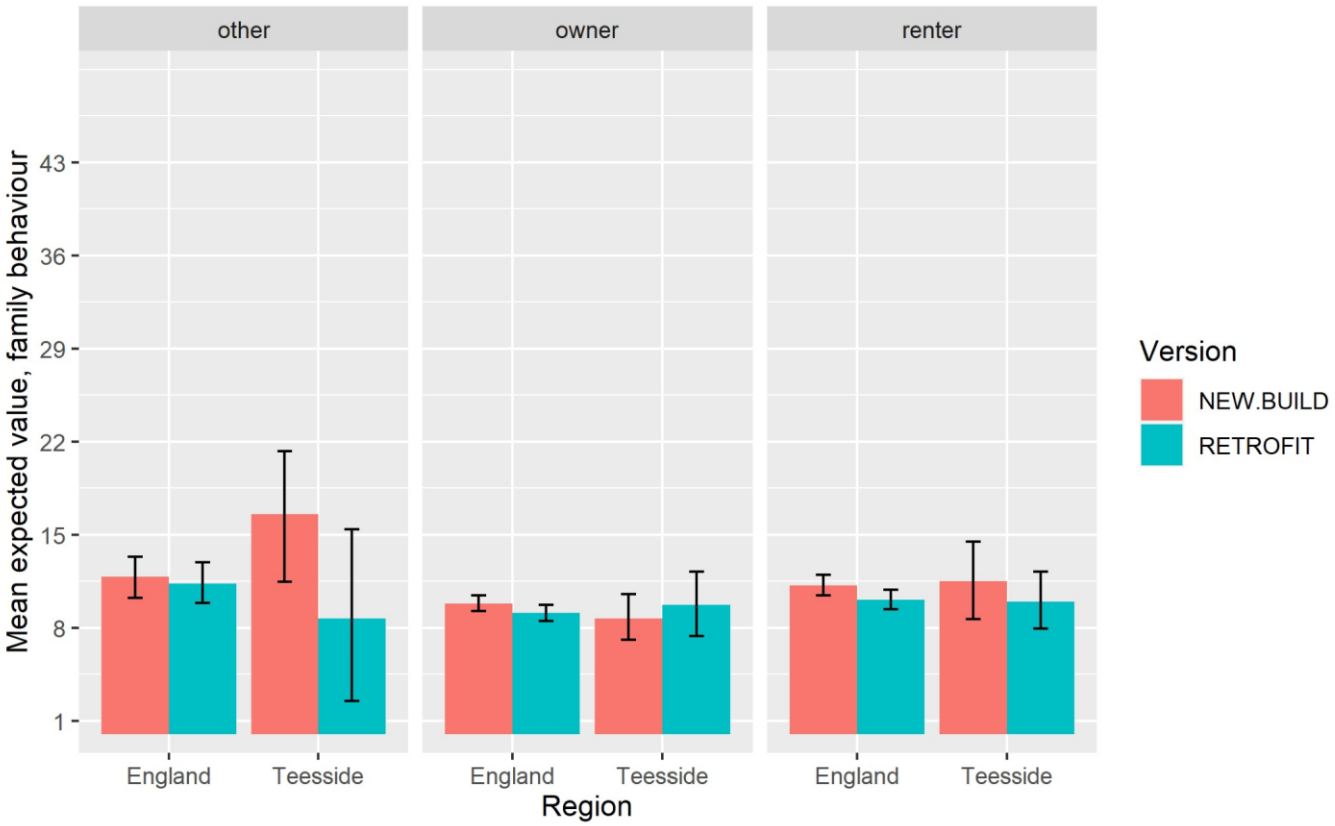
8
1
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean expected value, family behaviour
43
36
29
22
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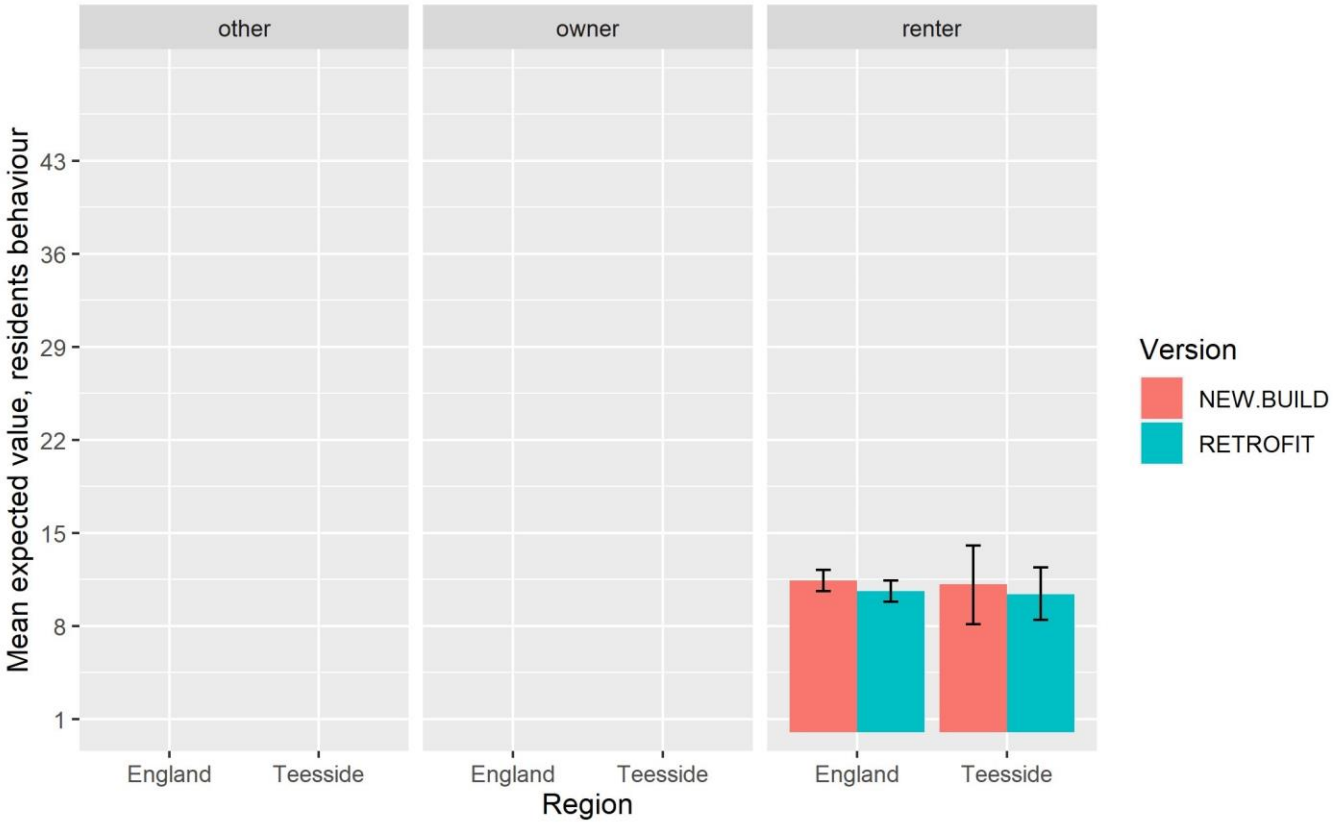
8
1
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean expected value, residents behaviour
43
36
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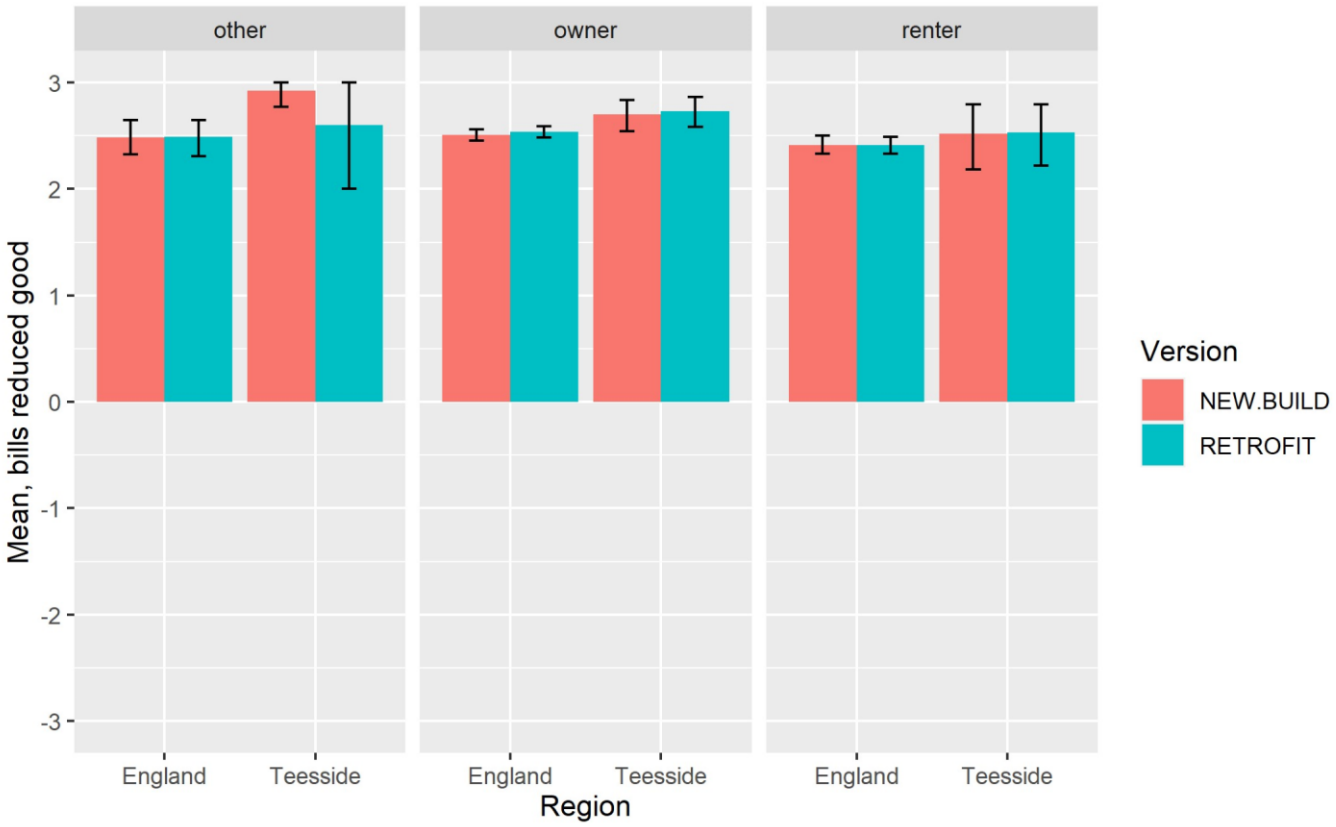
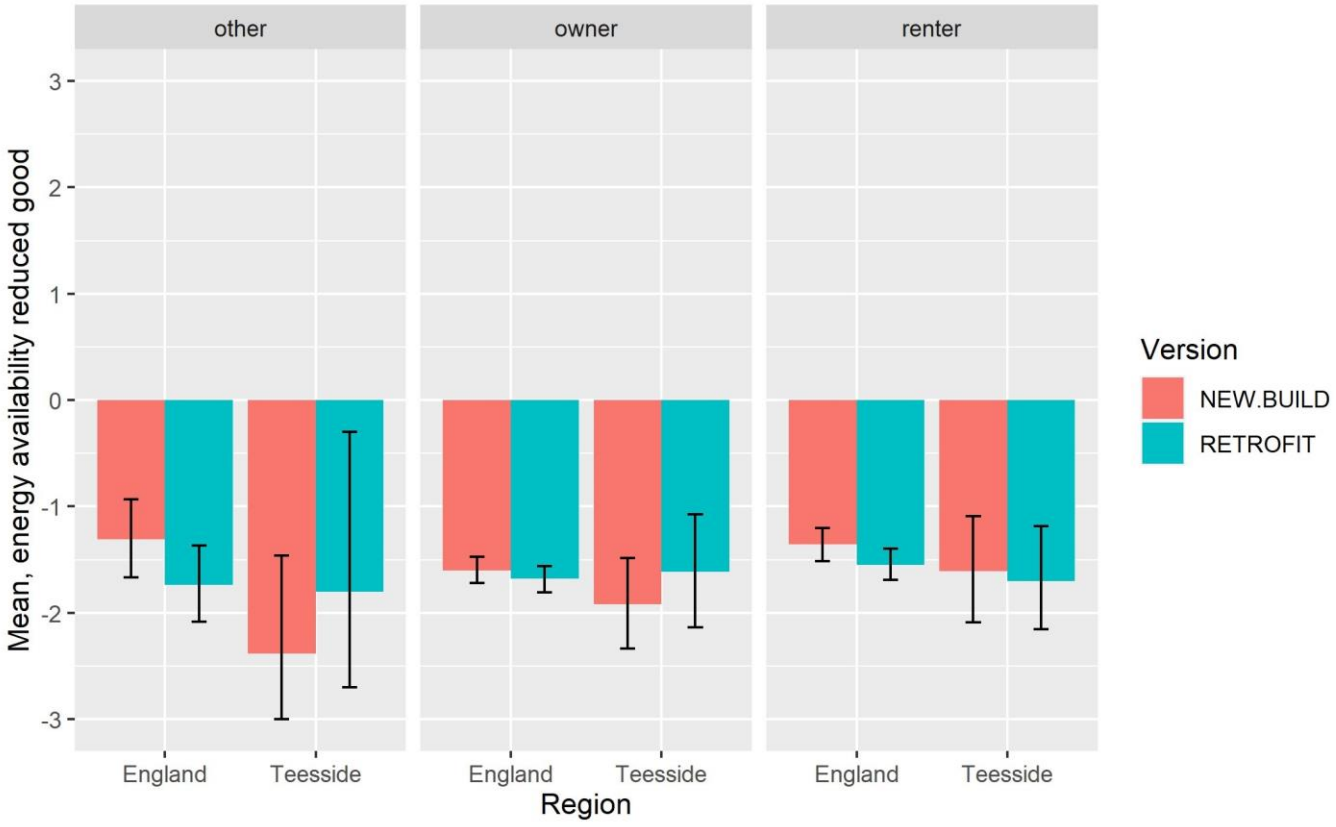
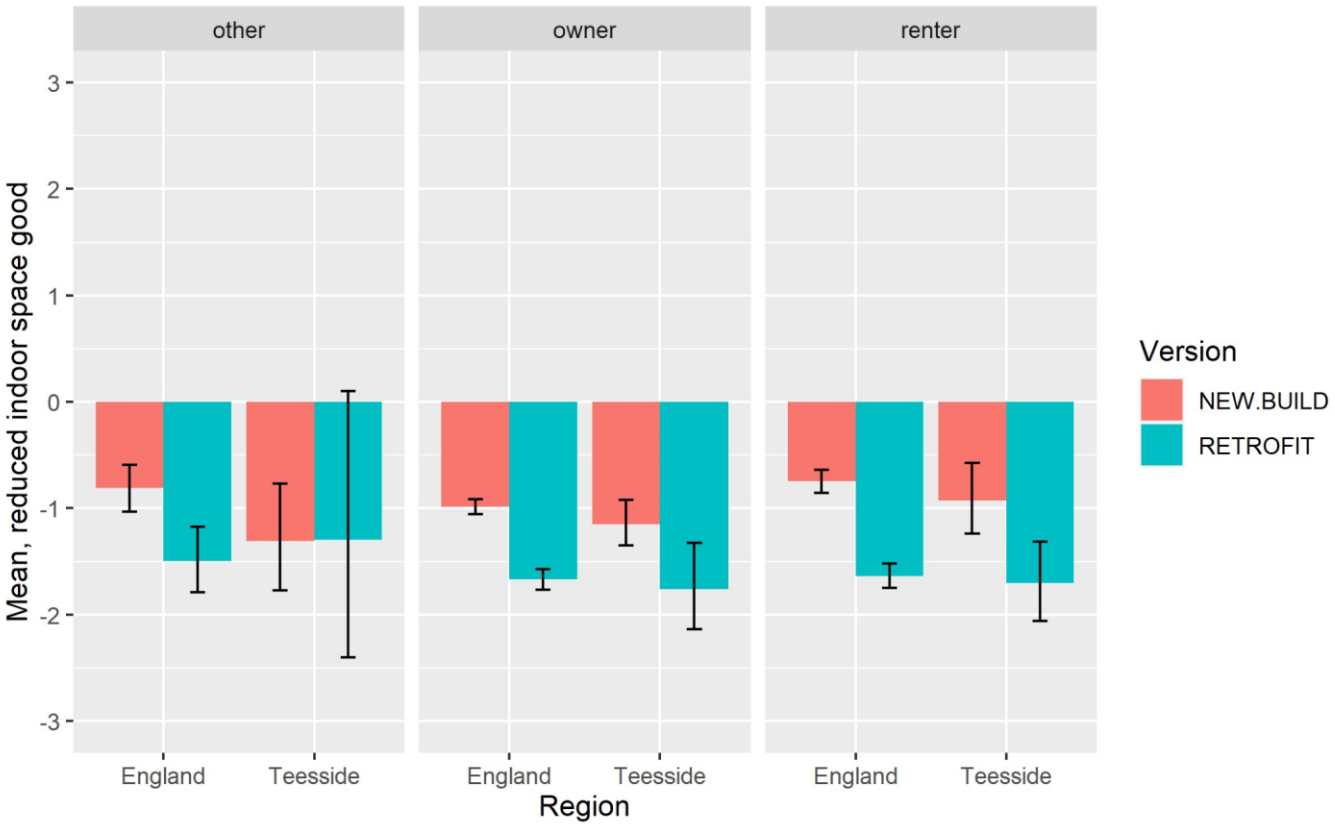
22
15
8
1
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean, bills reduced good
3
2
1
0
-1
-2
-3
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean, energy availability reduced good
3
2
1
0
-1
-2
-3
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean, reduced indoor space good
3
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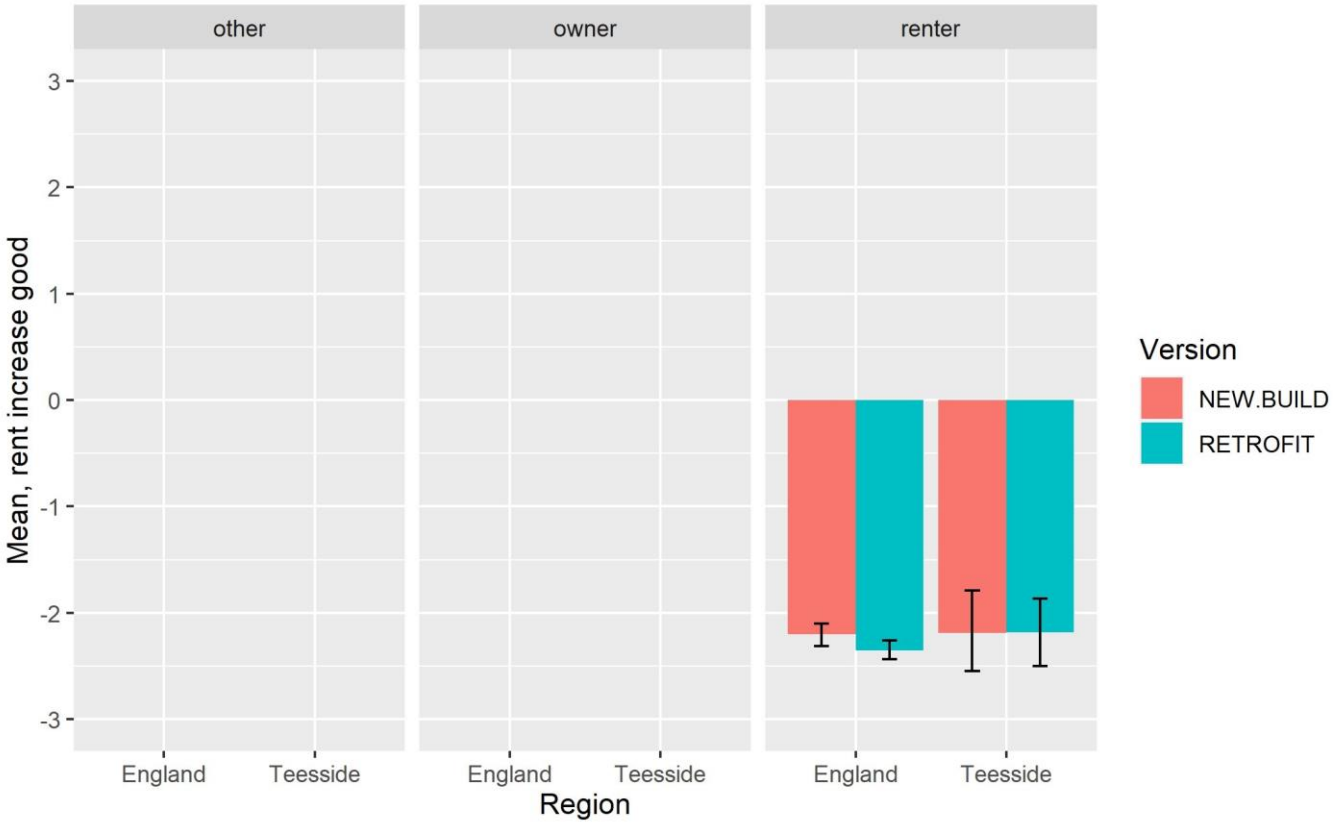
-2
-3
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean, rent increase good
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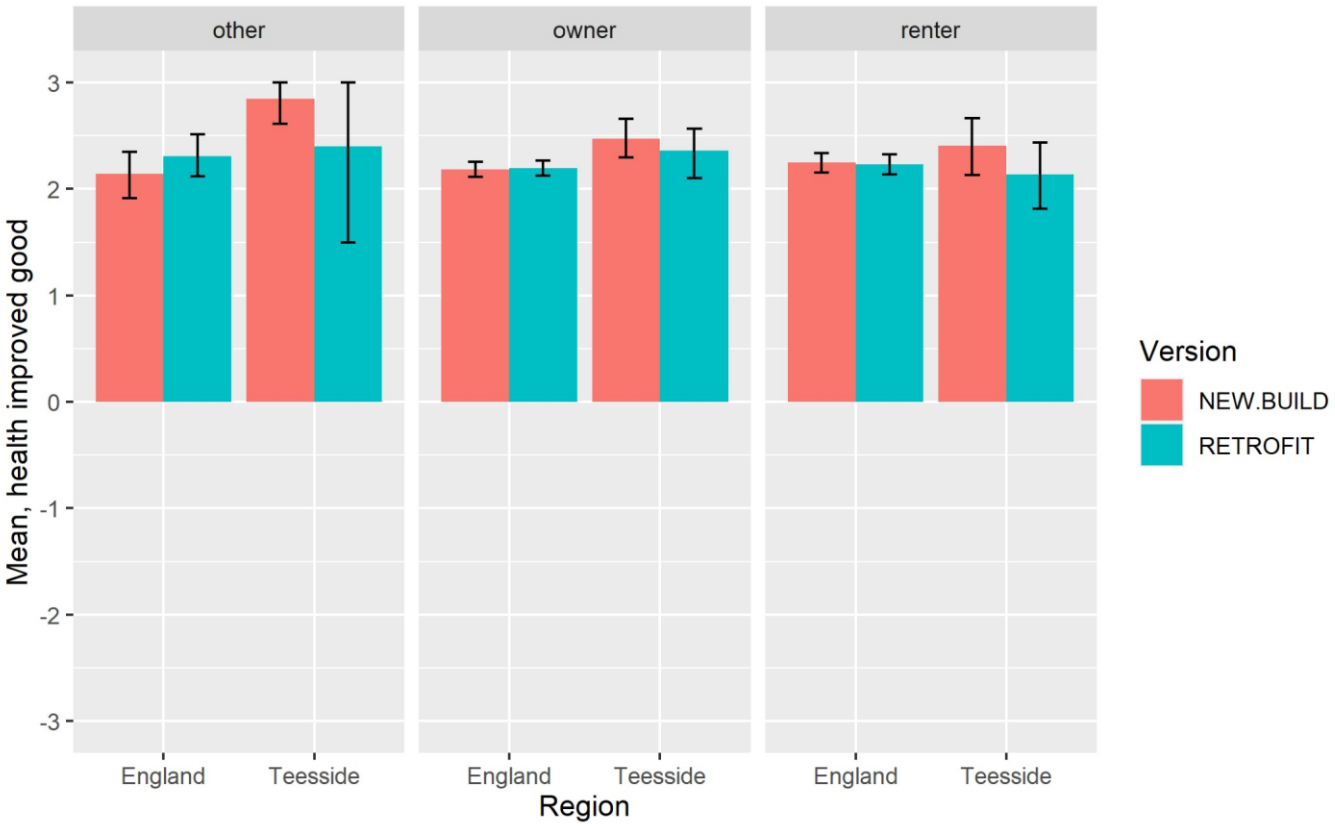
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
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renter
Mean, health improved good
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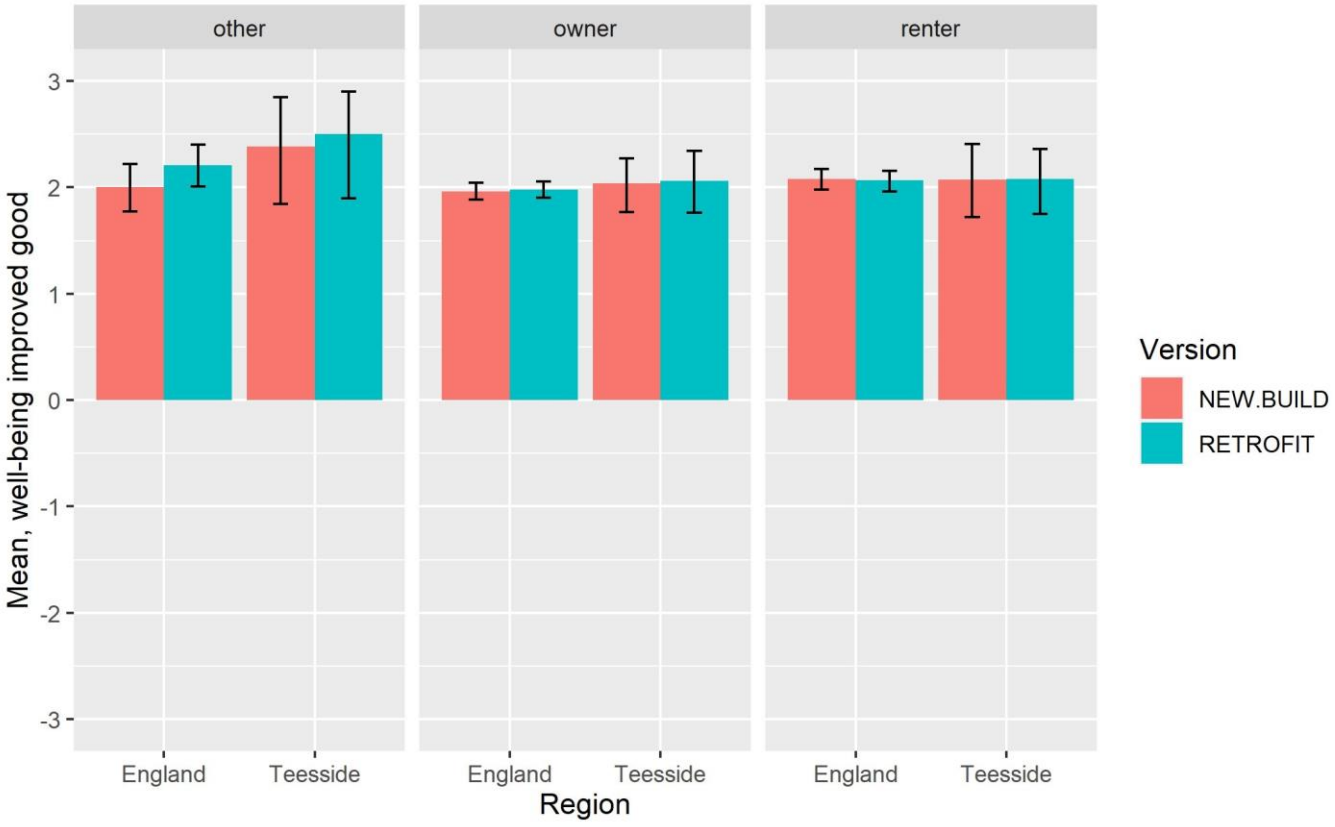
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean, well-being improved good
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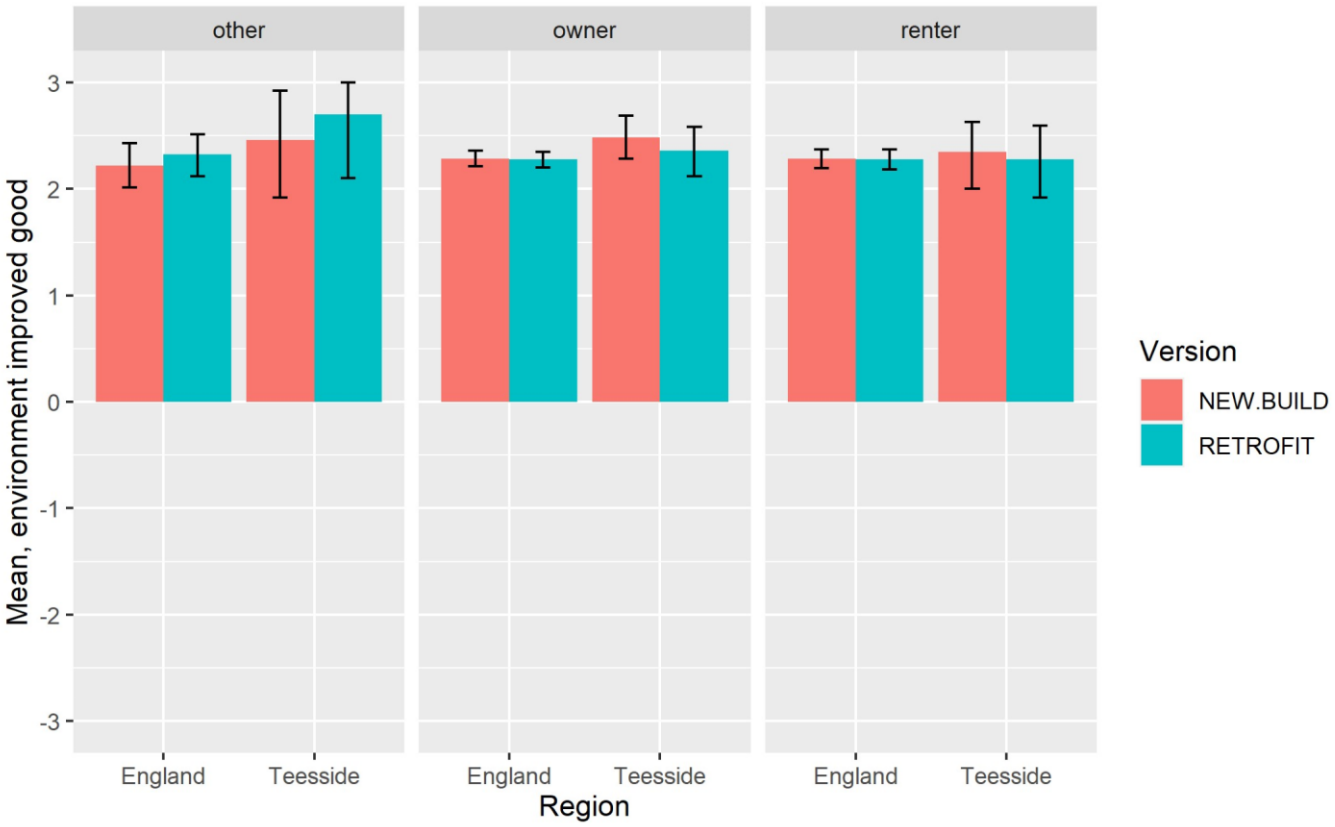
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean, environment improved good
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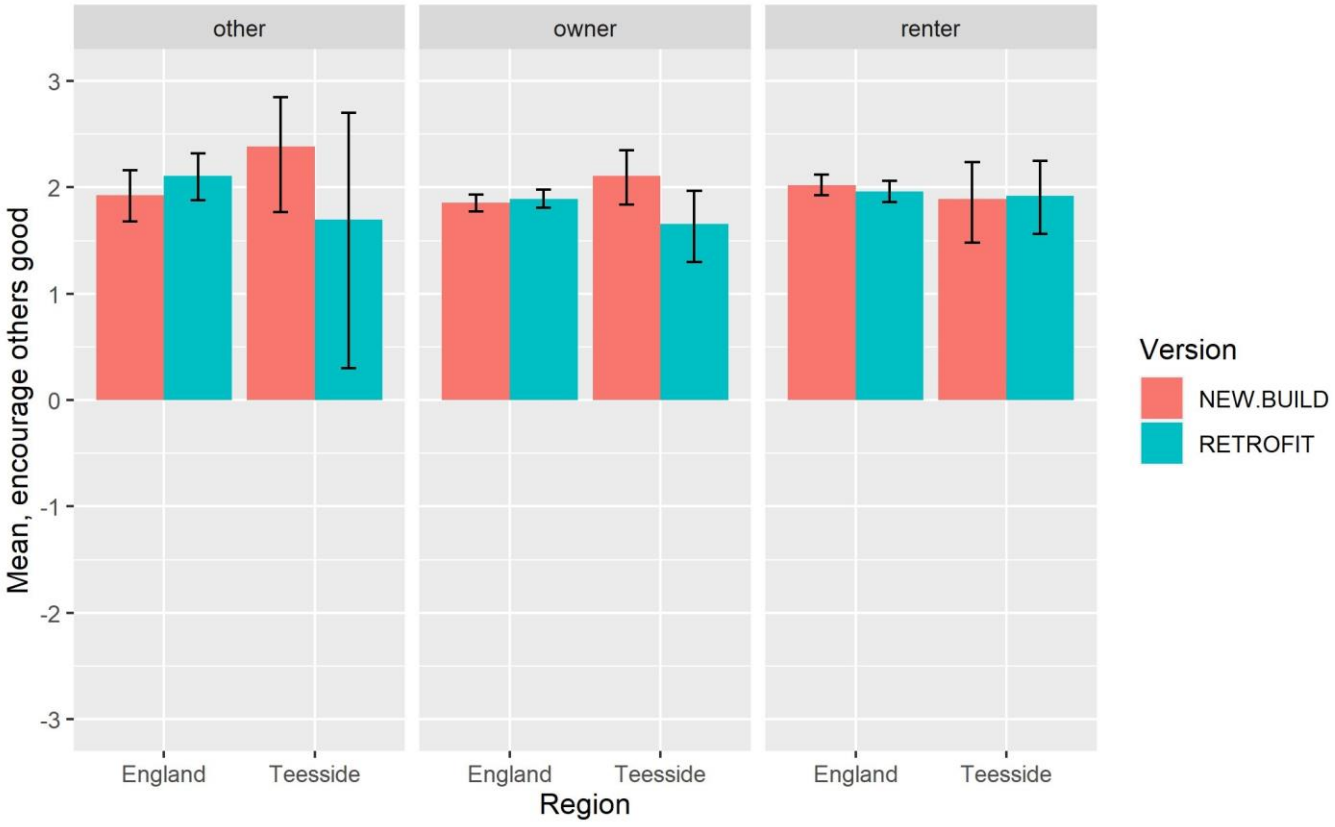
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean, encourage others good
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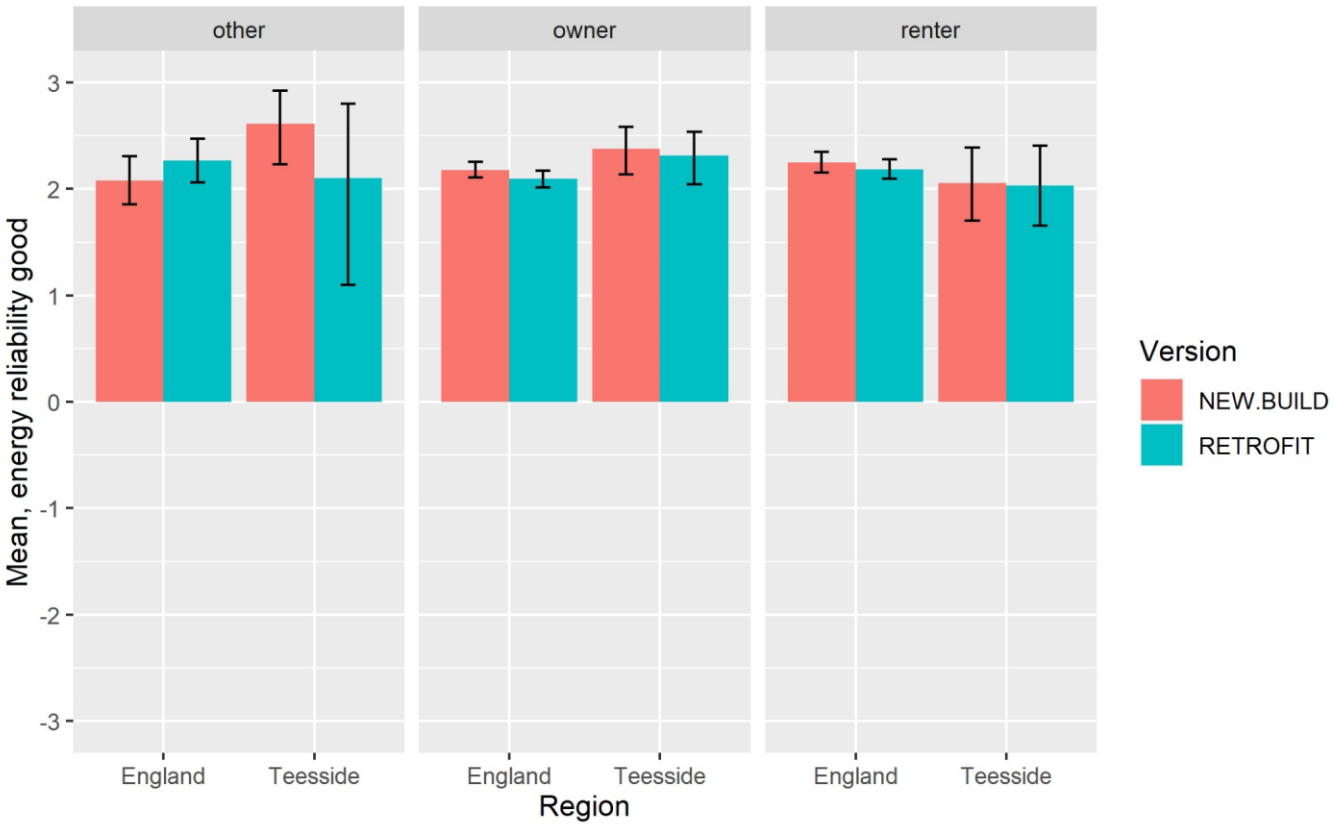
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean, energy reliability good
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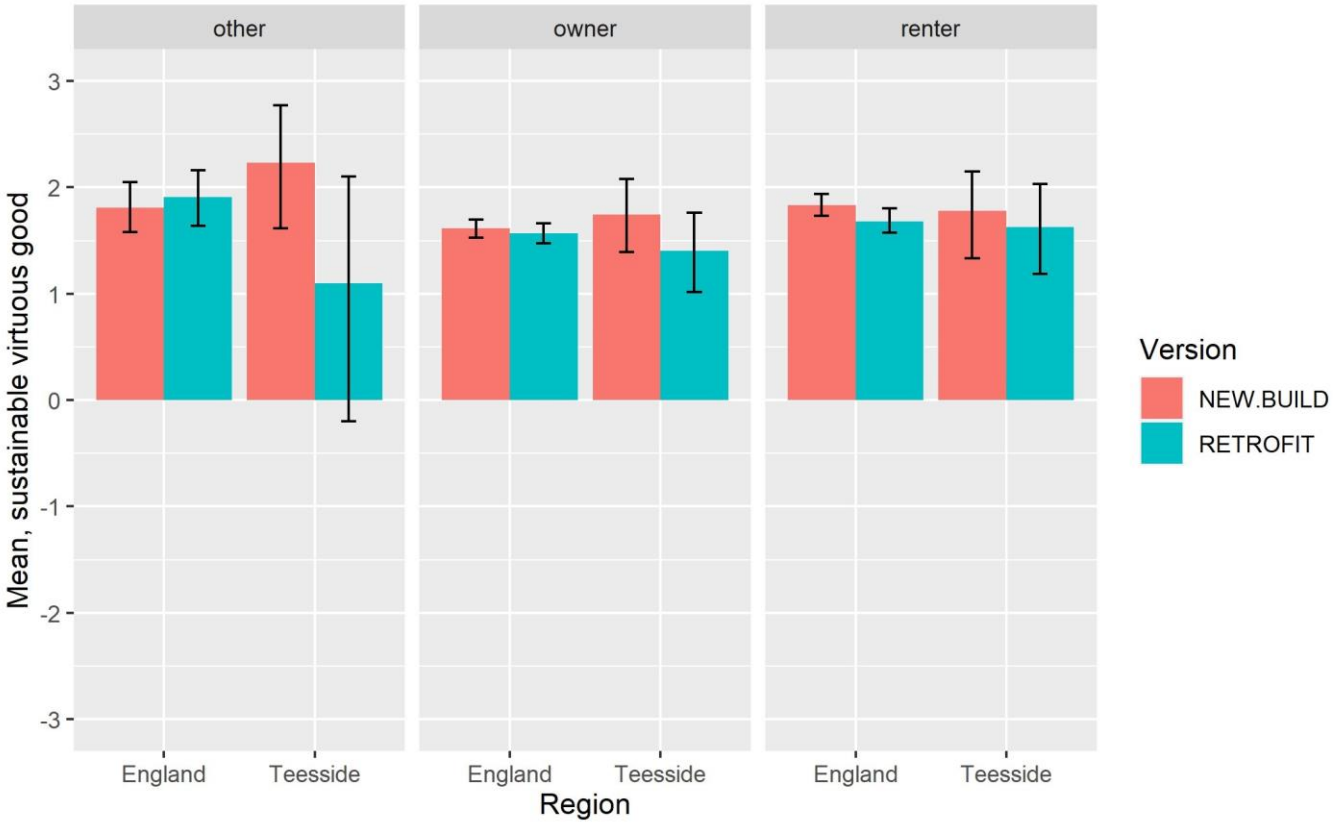
-2
-3
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean, sustainable virtuous good
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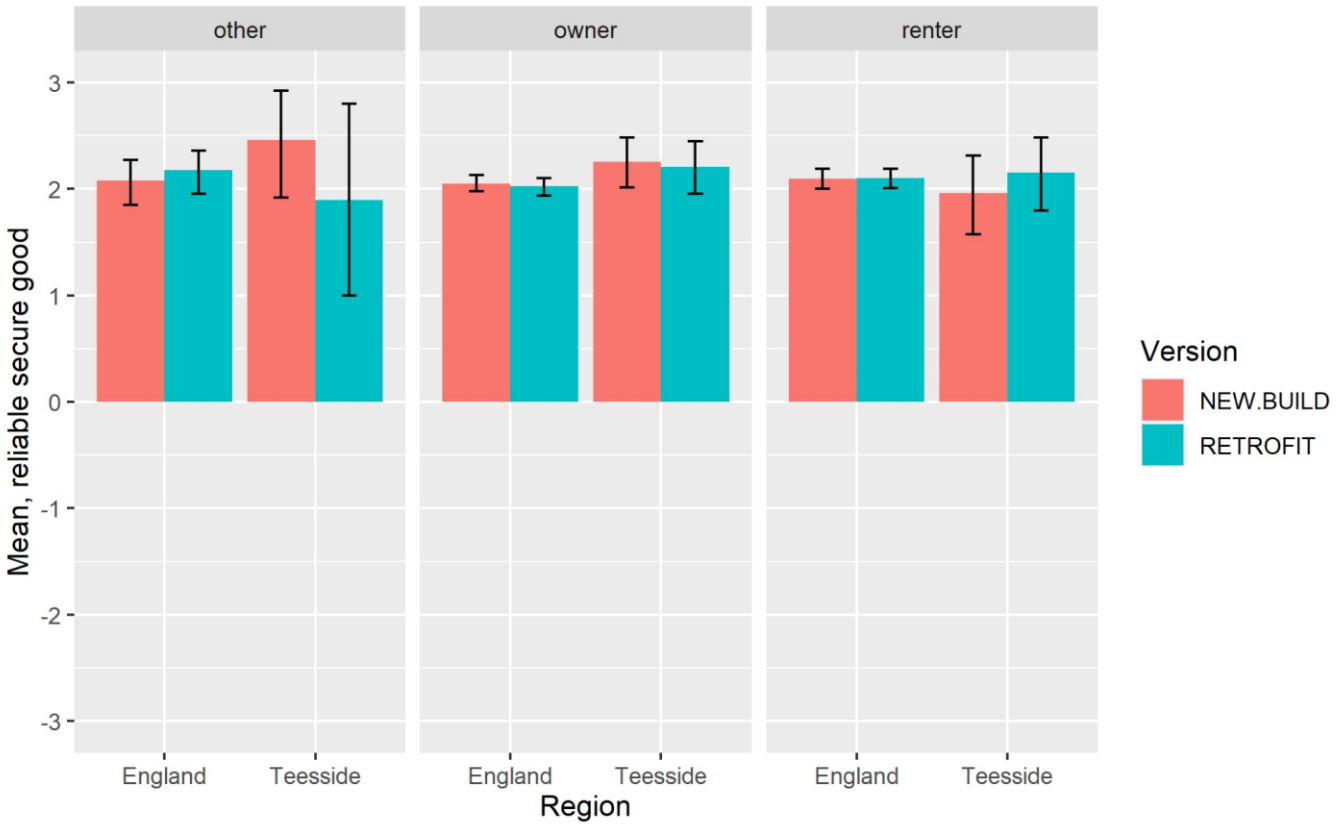
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean, reliable secure good
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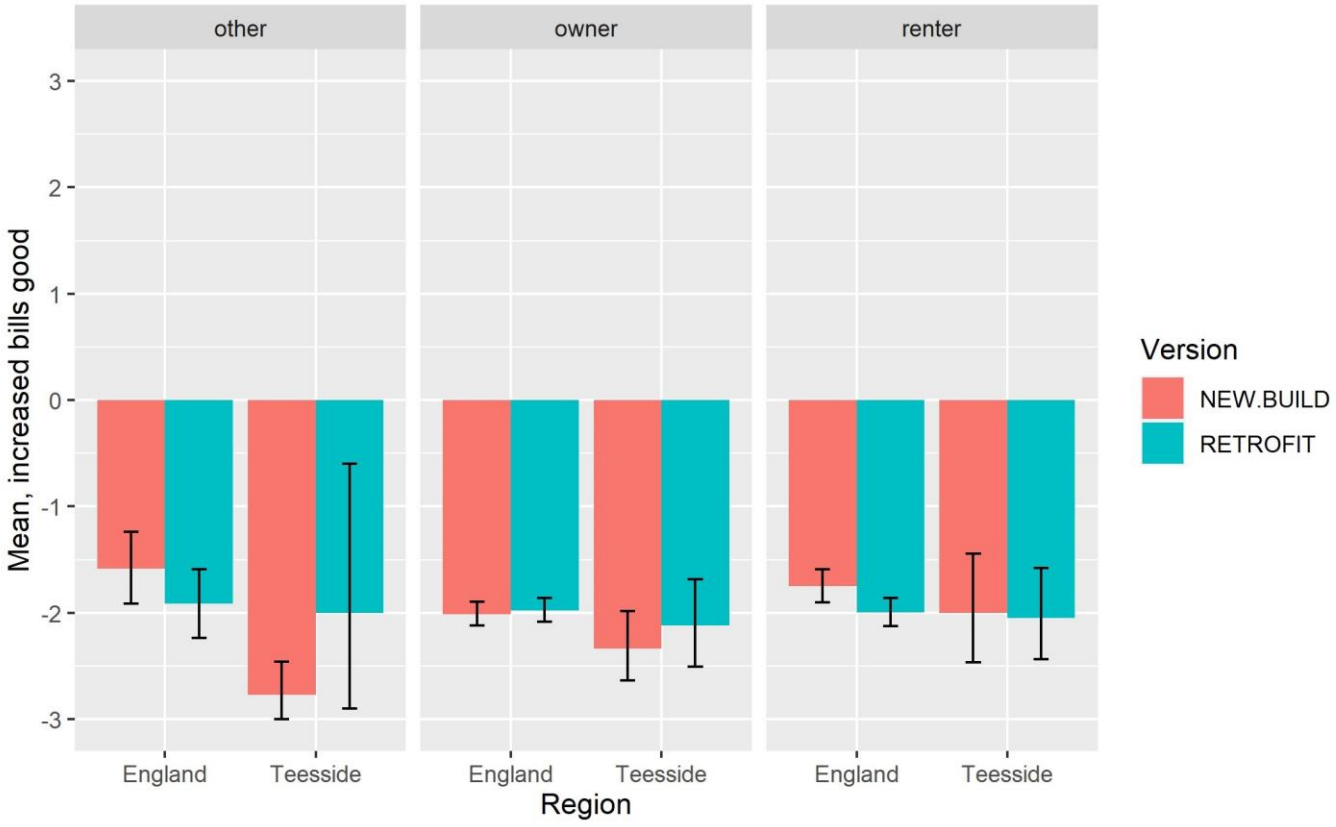
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean, increased bills good
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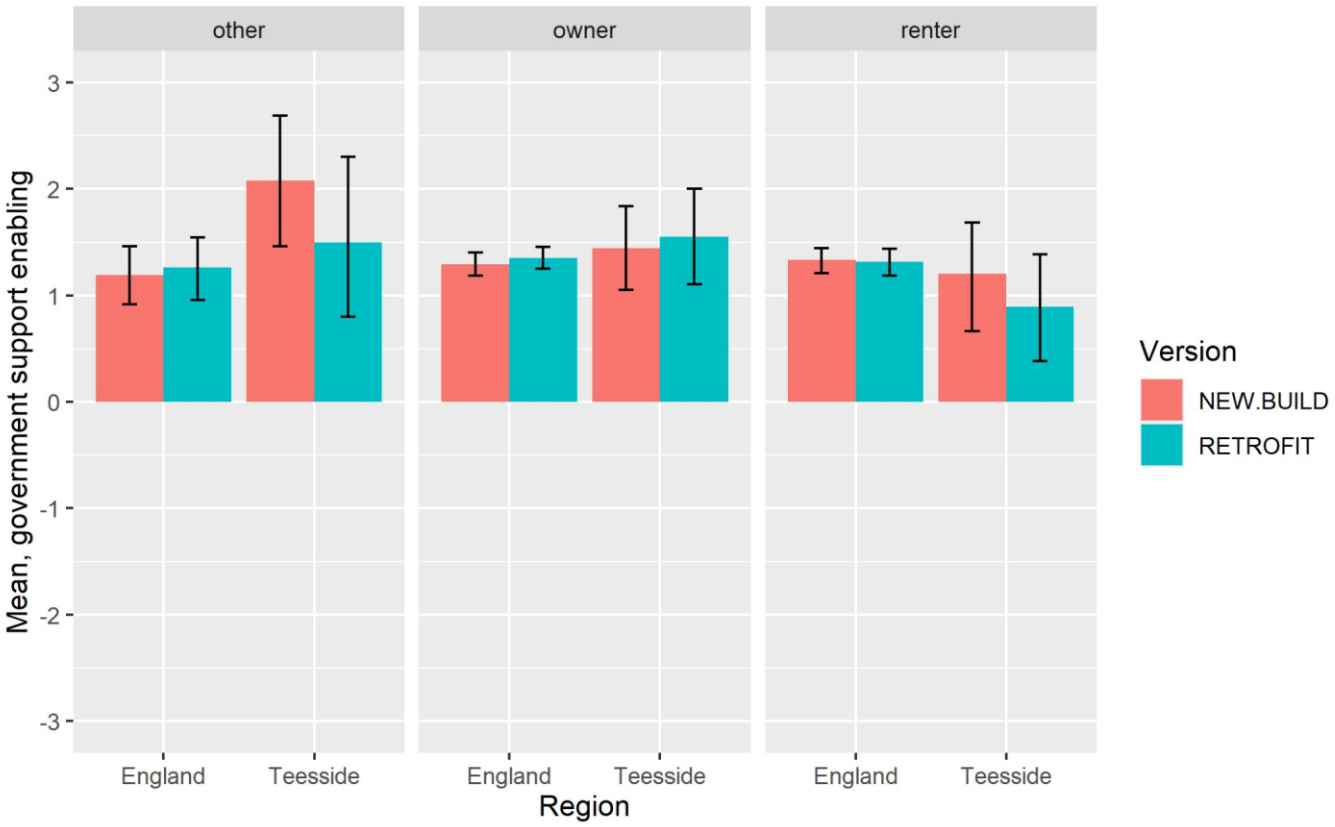
-1
-2
-3
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean, government support enabling
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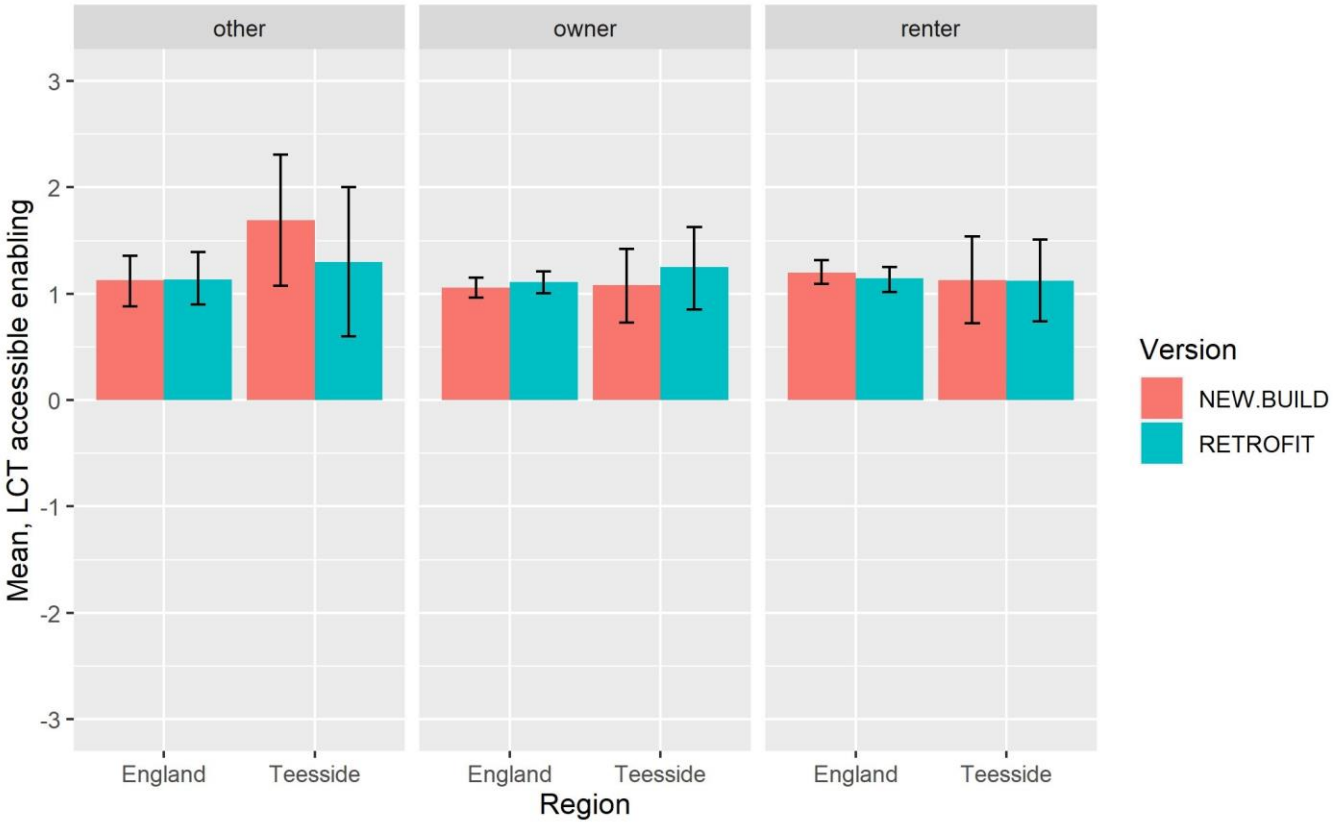
-1
-2
-3
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean, LCT accessible enabling
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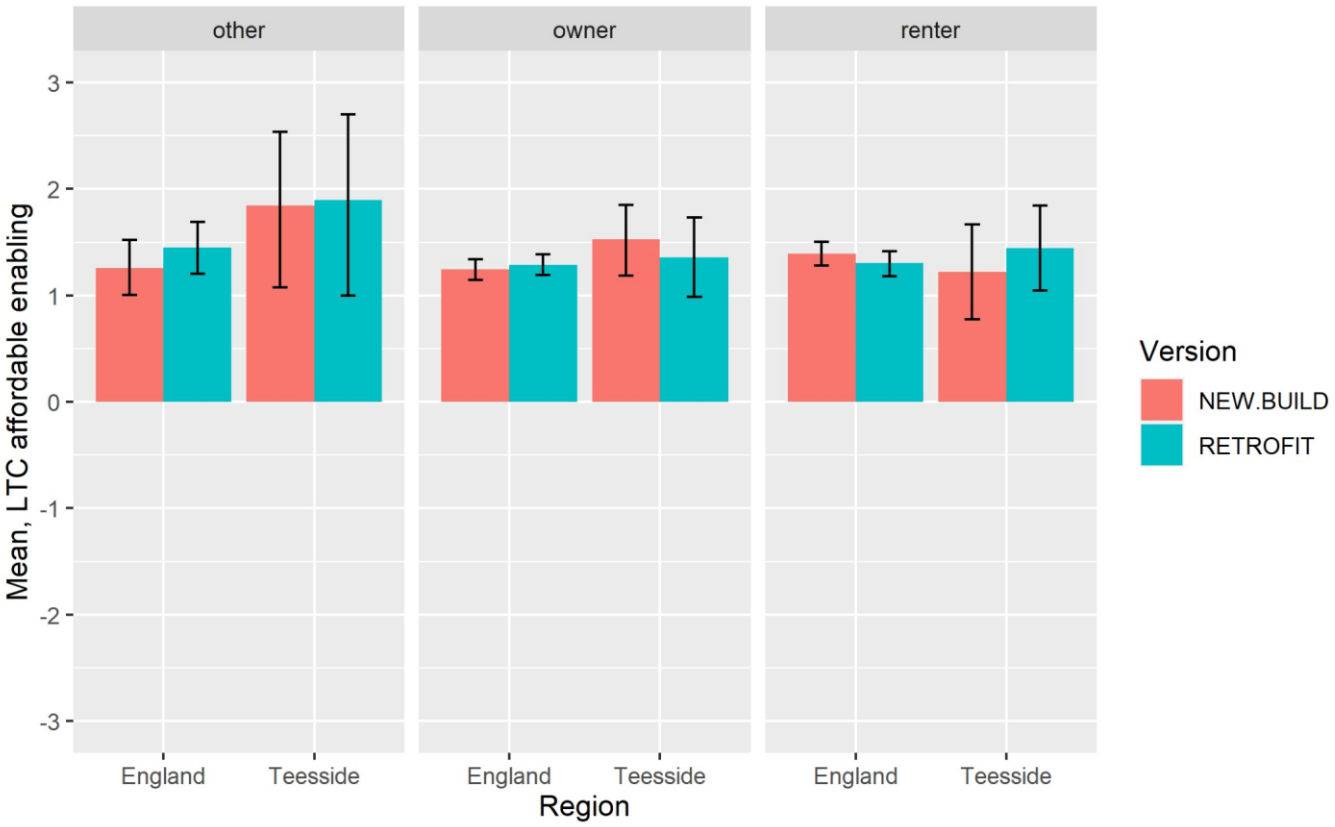
-2
-3
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean, LTC affordable enabling
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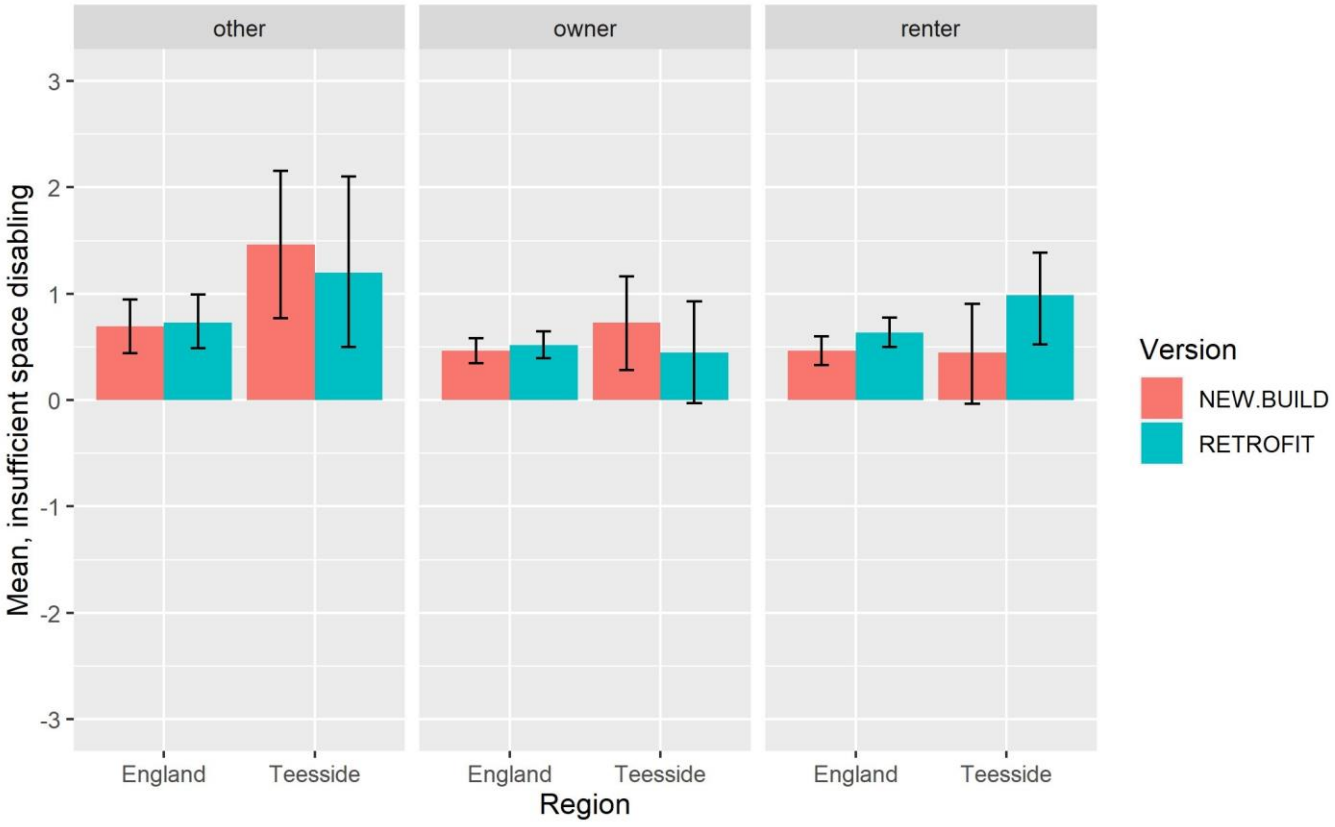
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean, insufficient space disabling
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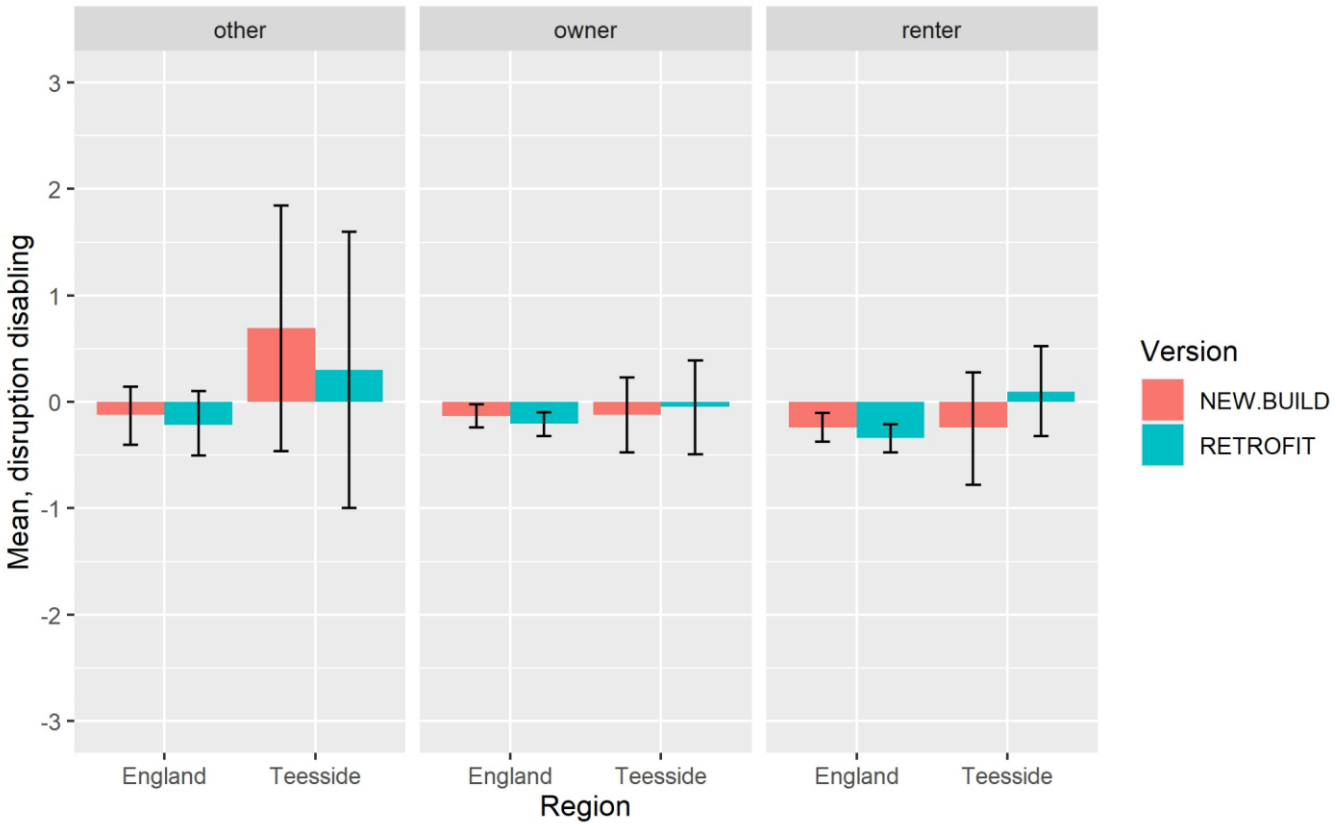
-2
-3
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean, disruption disabling
3
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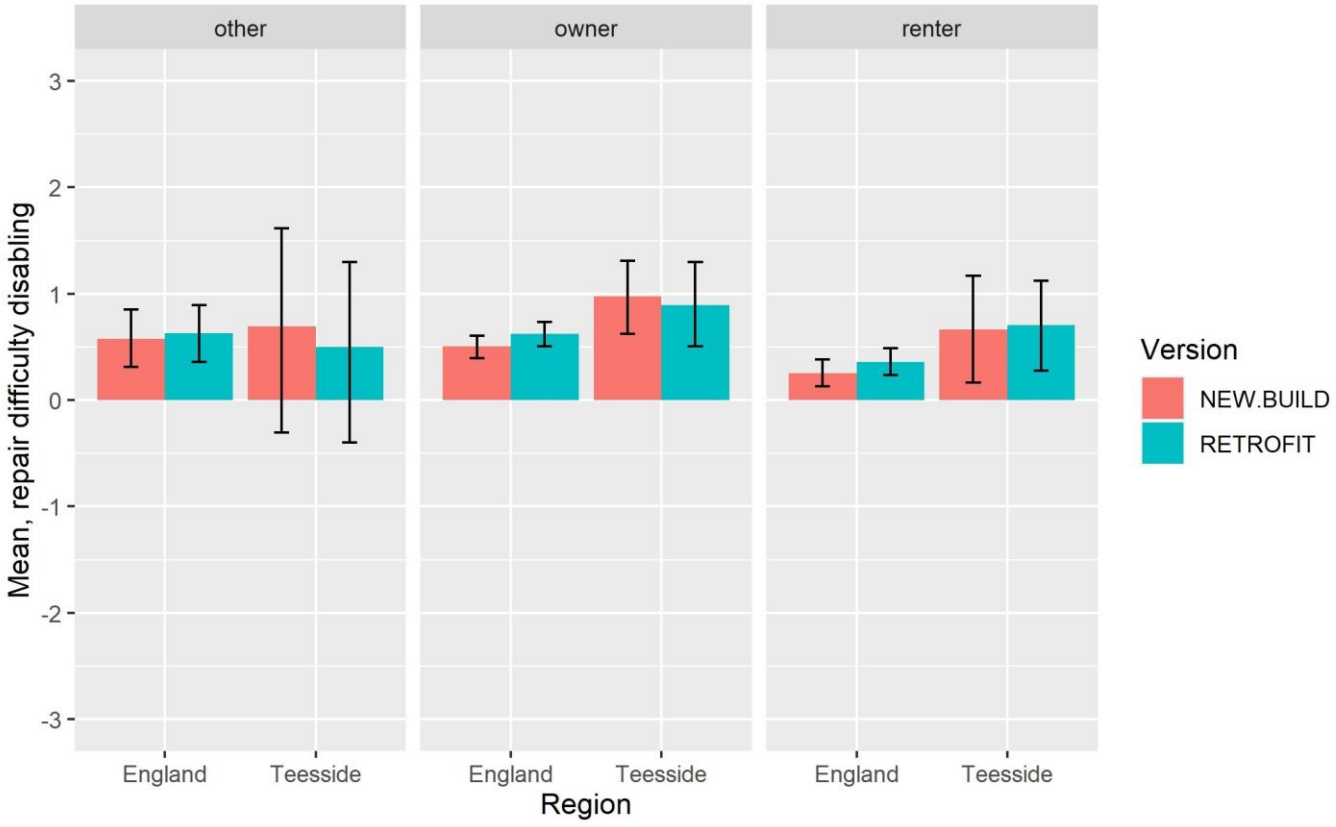
-2
-3
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean, repair difficulty disabling
3
2
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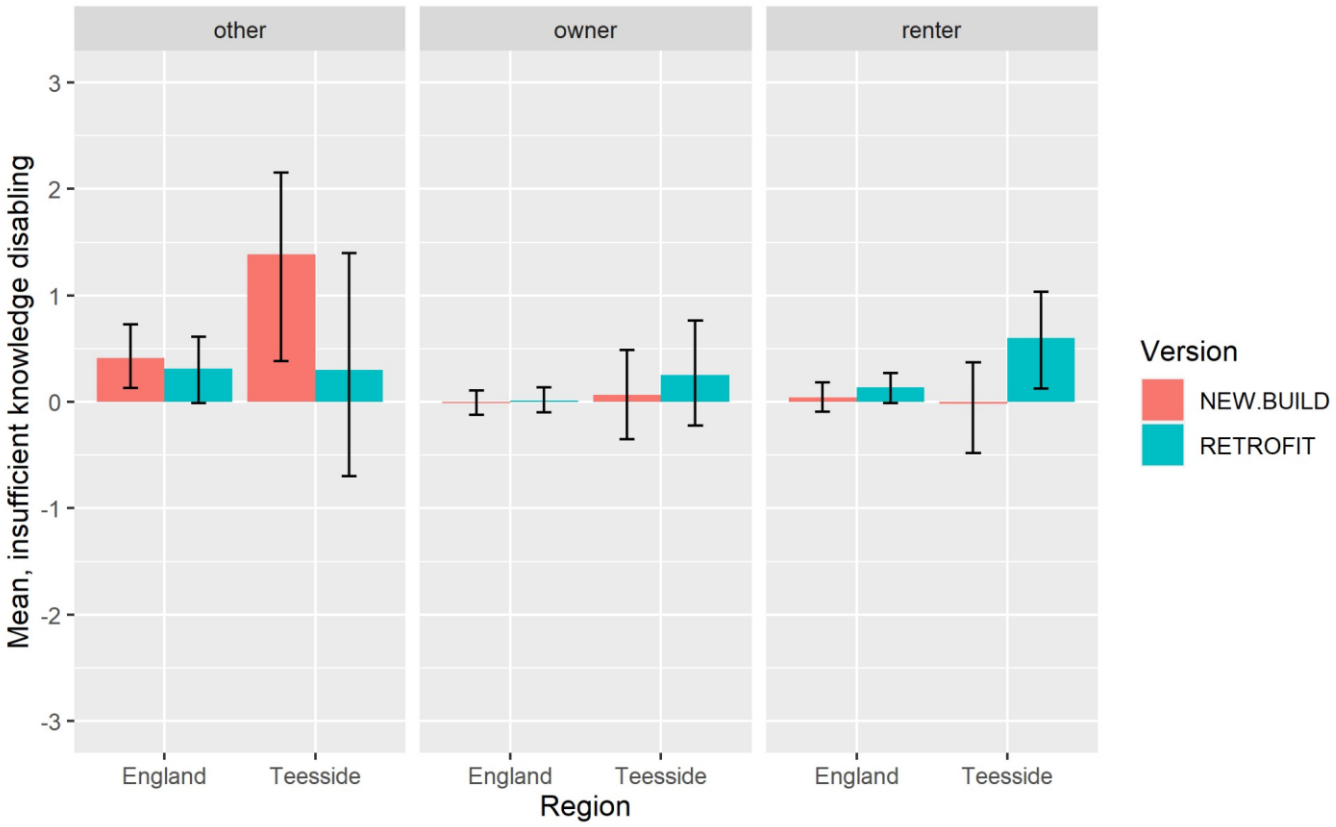
-2
-3
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean, insufficient knowledge disabling
3
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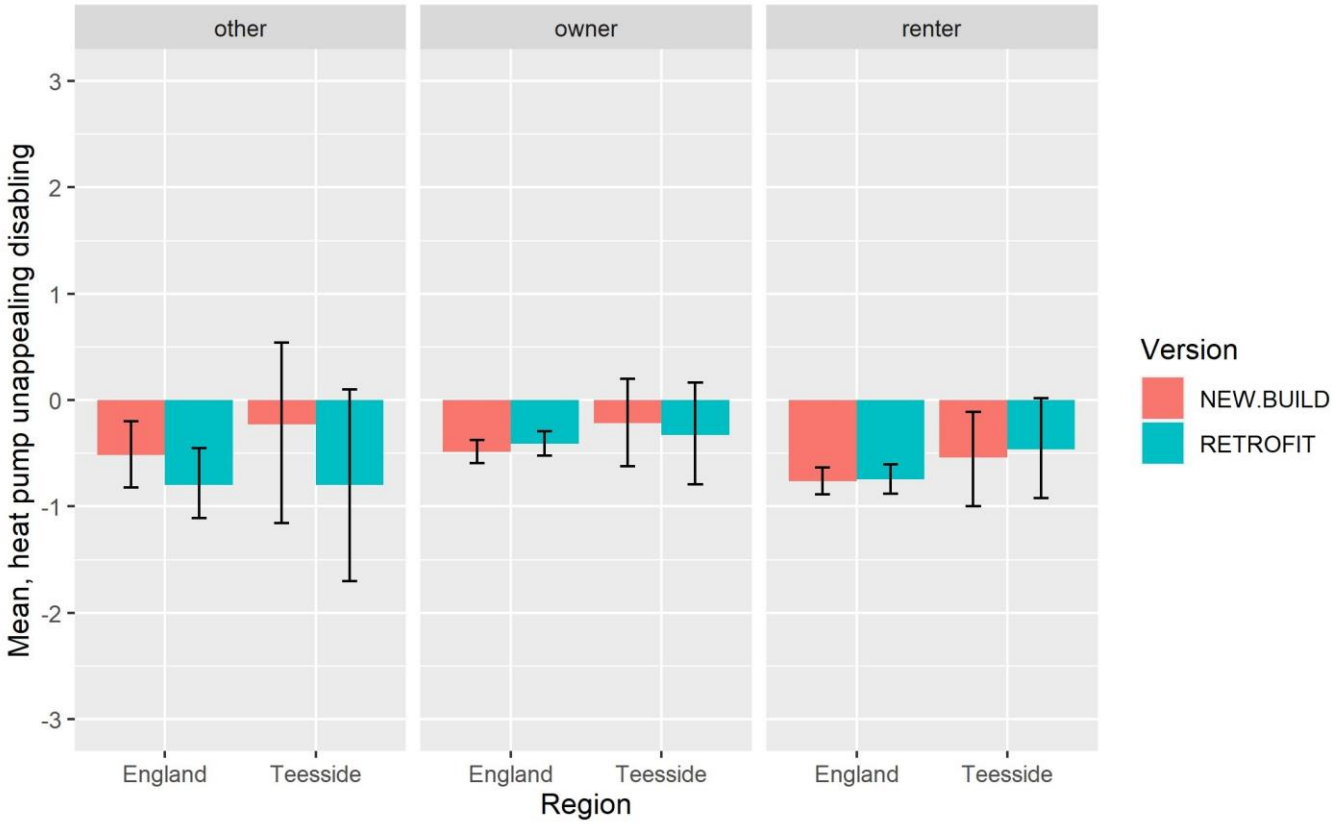
-2
-3
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean, heat pump unappealing disabling
3
2
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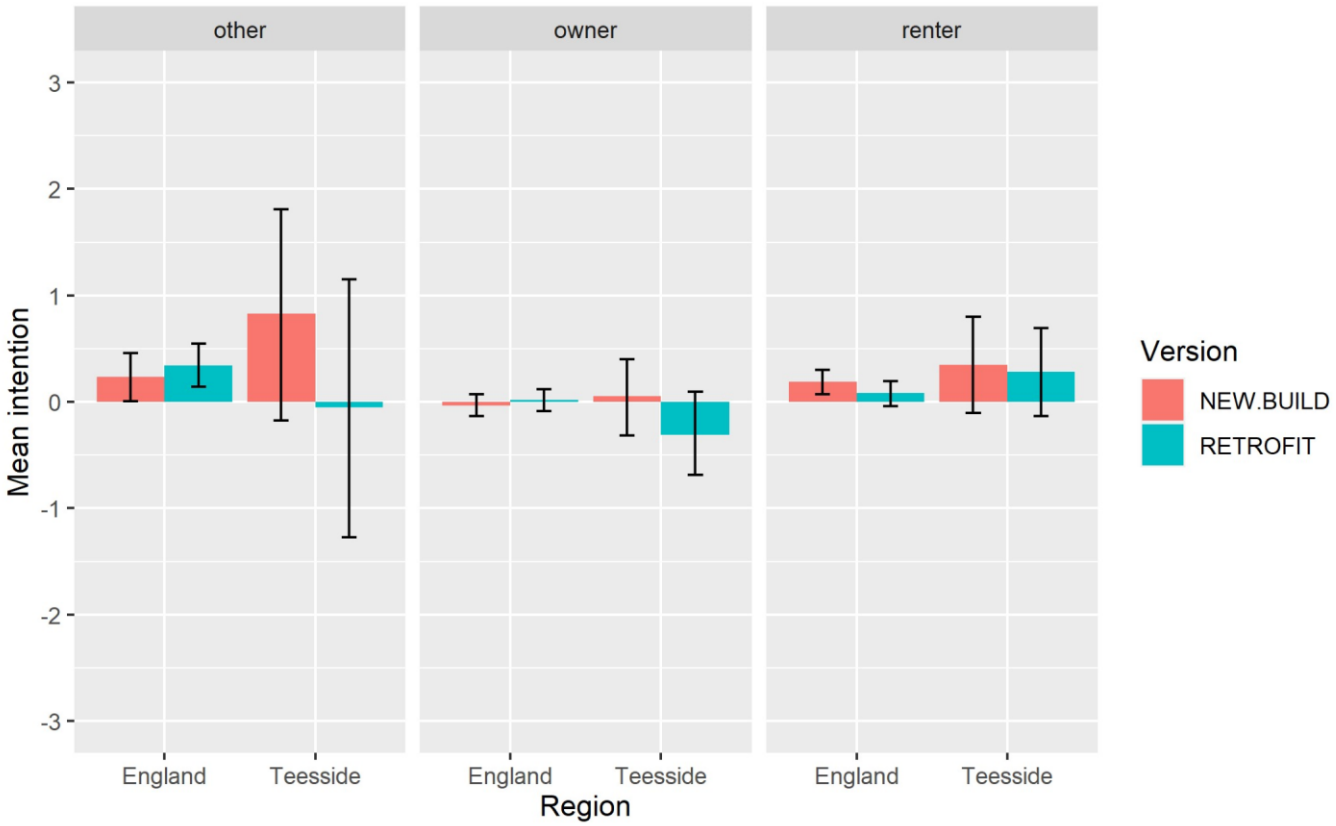
-2
-3
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean intention
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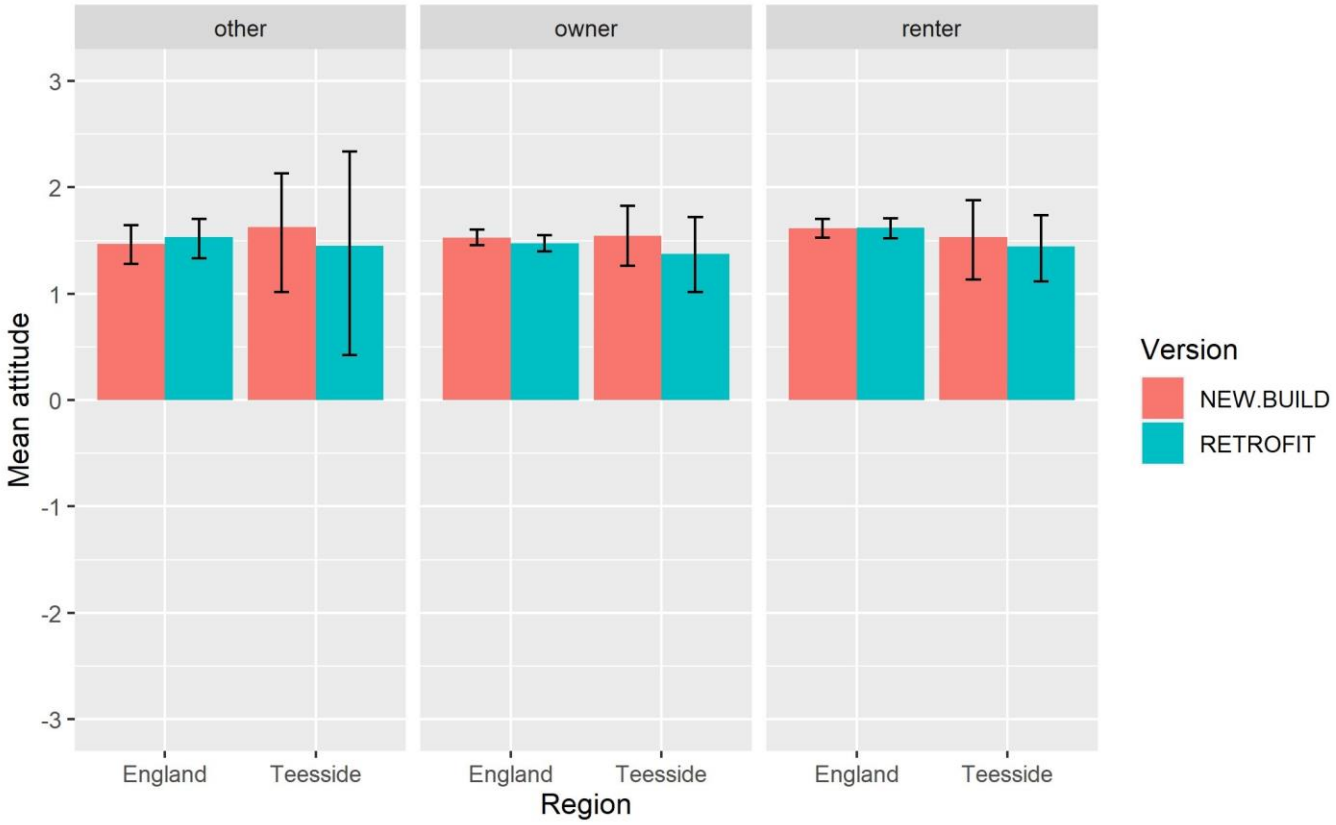
-3
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean attitude
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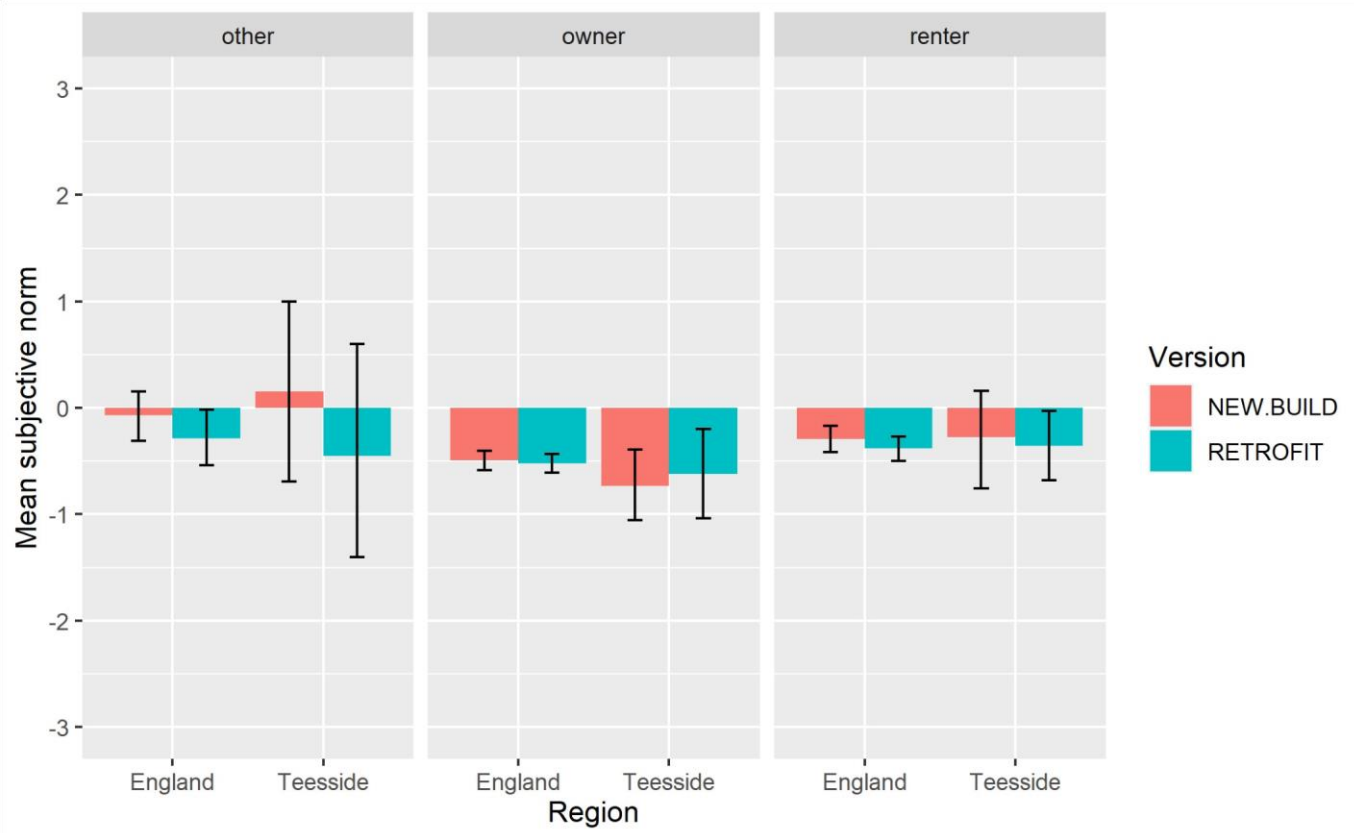
-3
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean subjective norm
3
2
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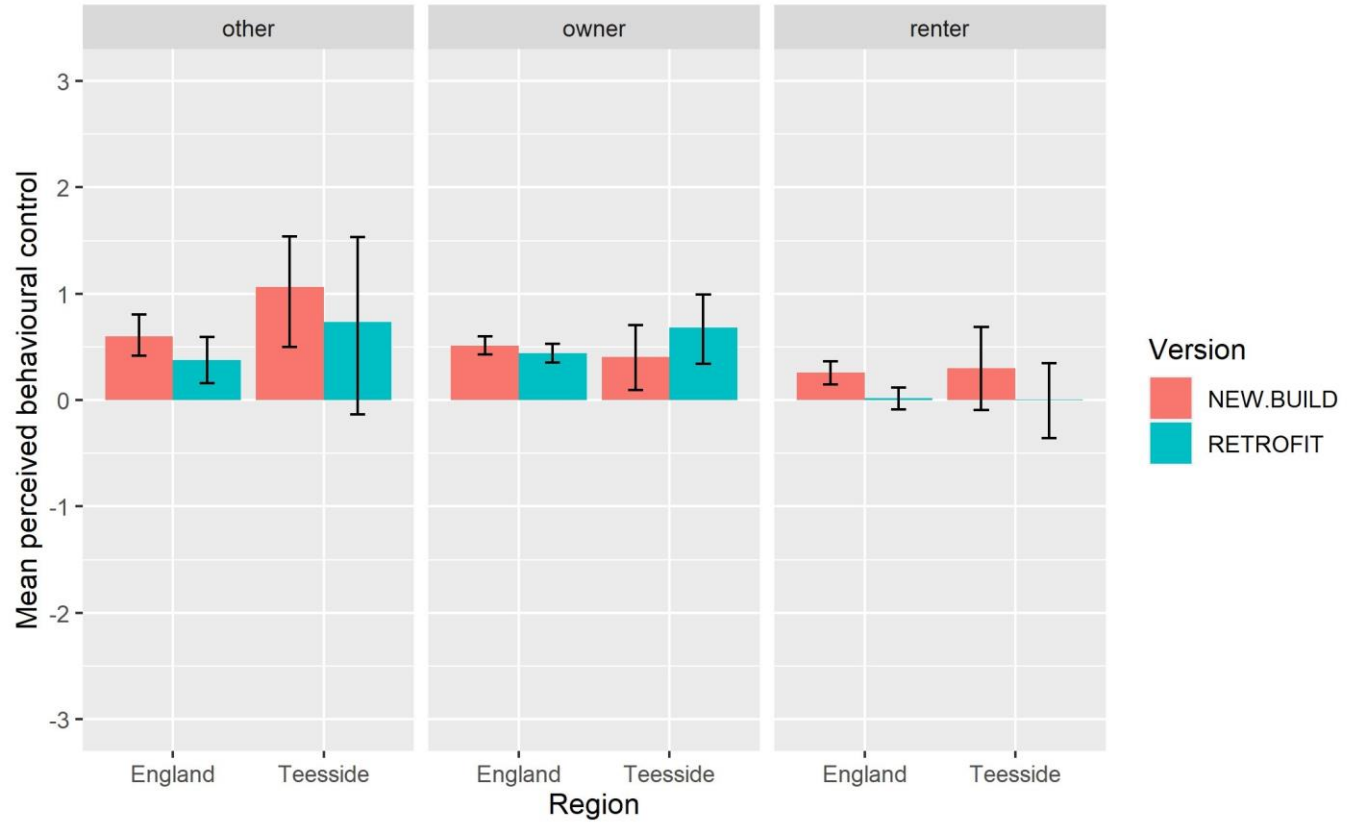
-2
-3
England
Teesside
Region
Version
NEW.BUILD
RETROFIT


other
owner
renter
Mean perceived behavioural control
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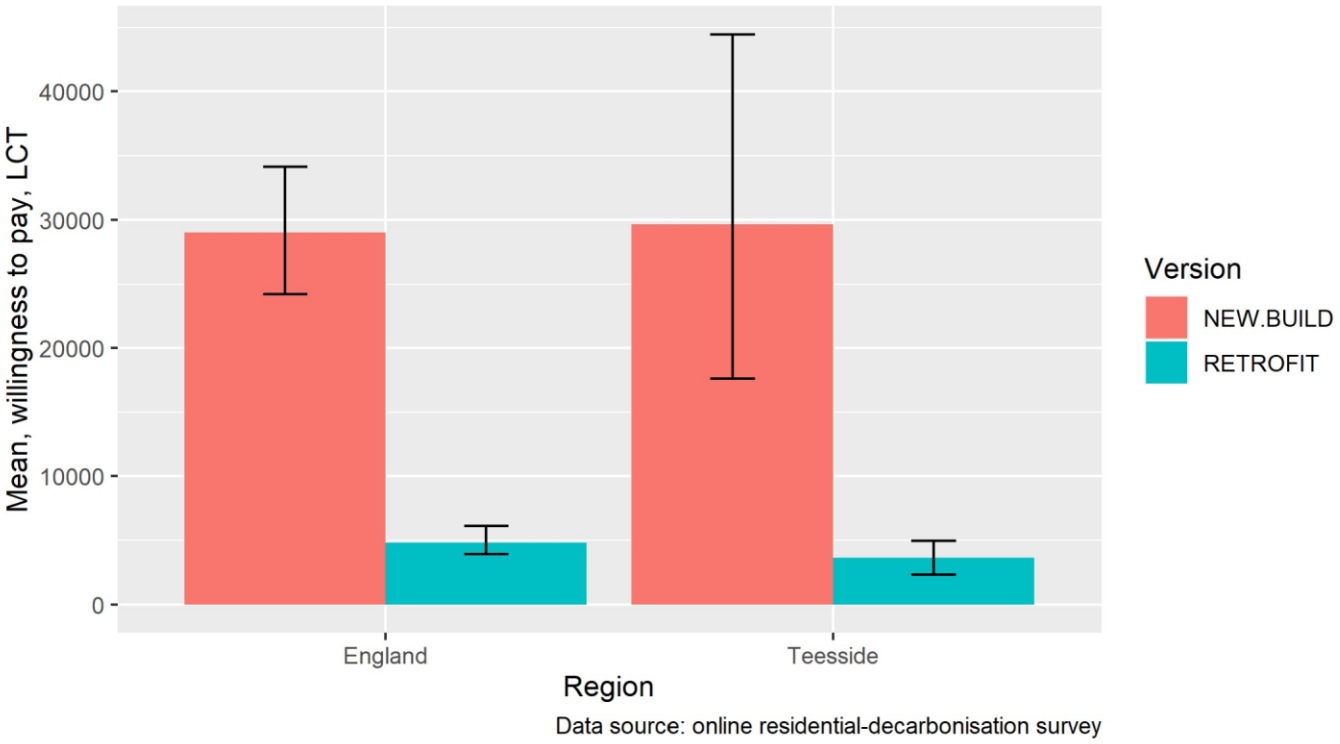
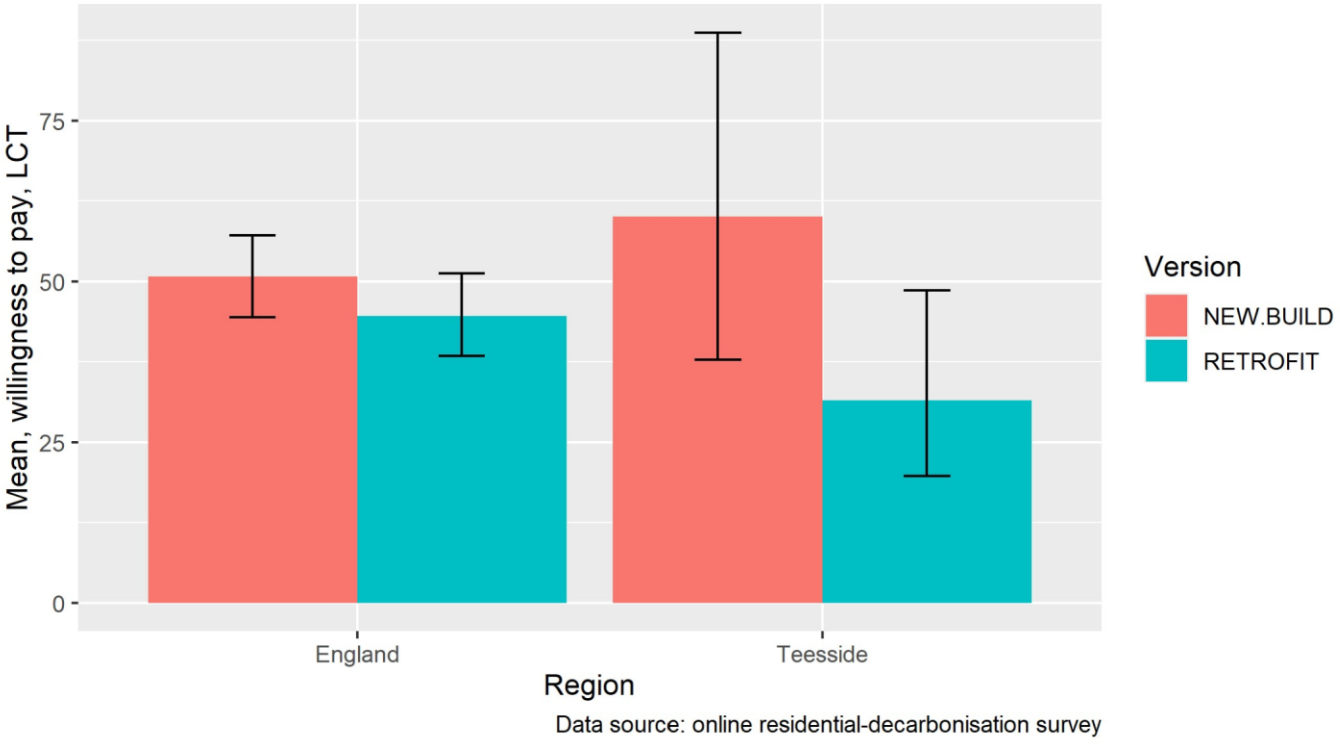
2
1
0
-1
-2
-3
England
Teesside
Region
Version
NEW.BUILD
RETROFIT

Owner



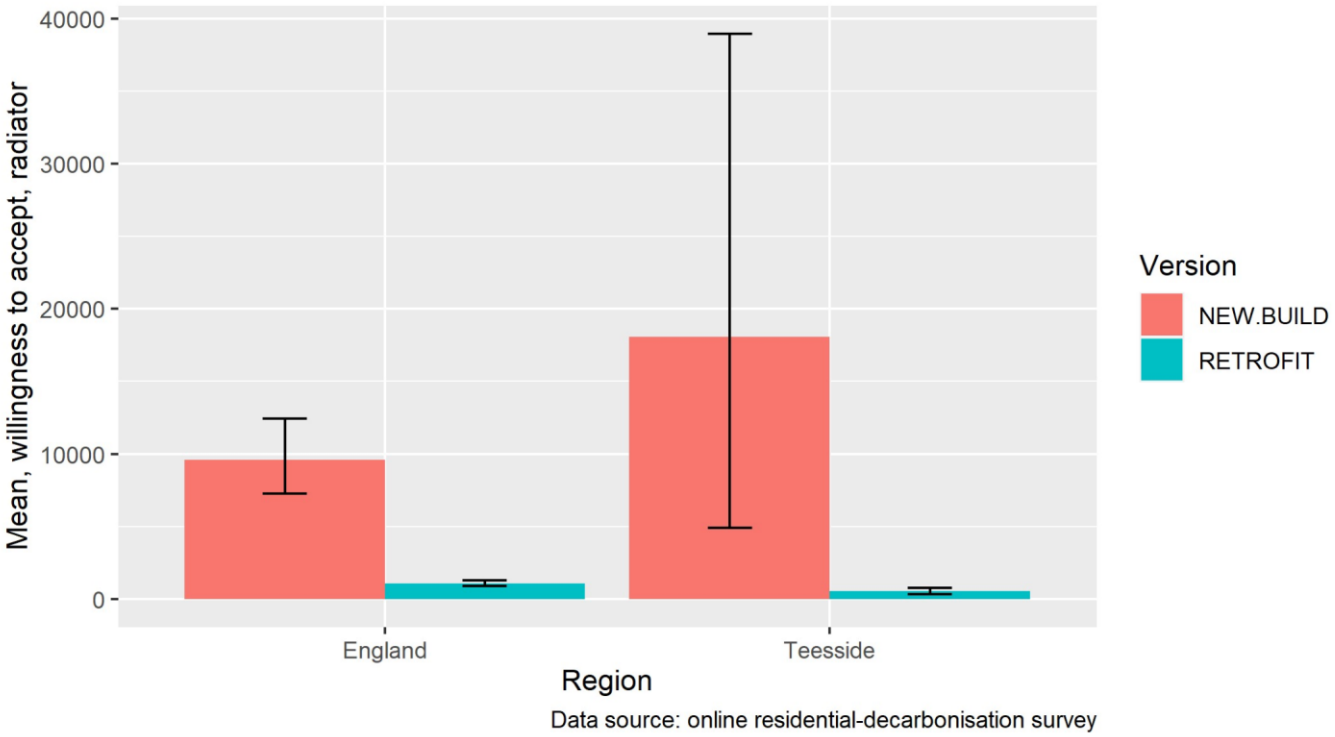
Data source: online residential-decarbonisation survey

Renter



Data source: online residential-decarbonisation survey

Owner



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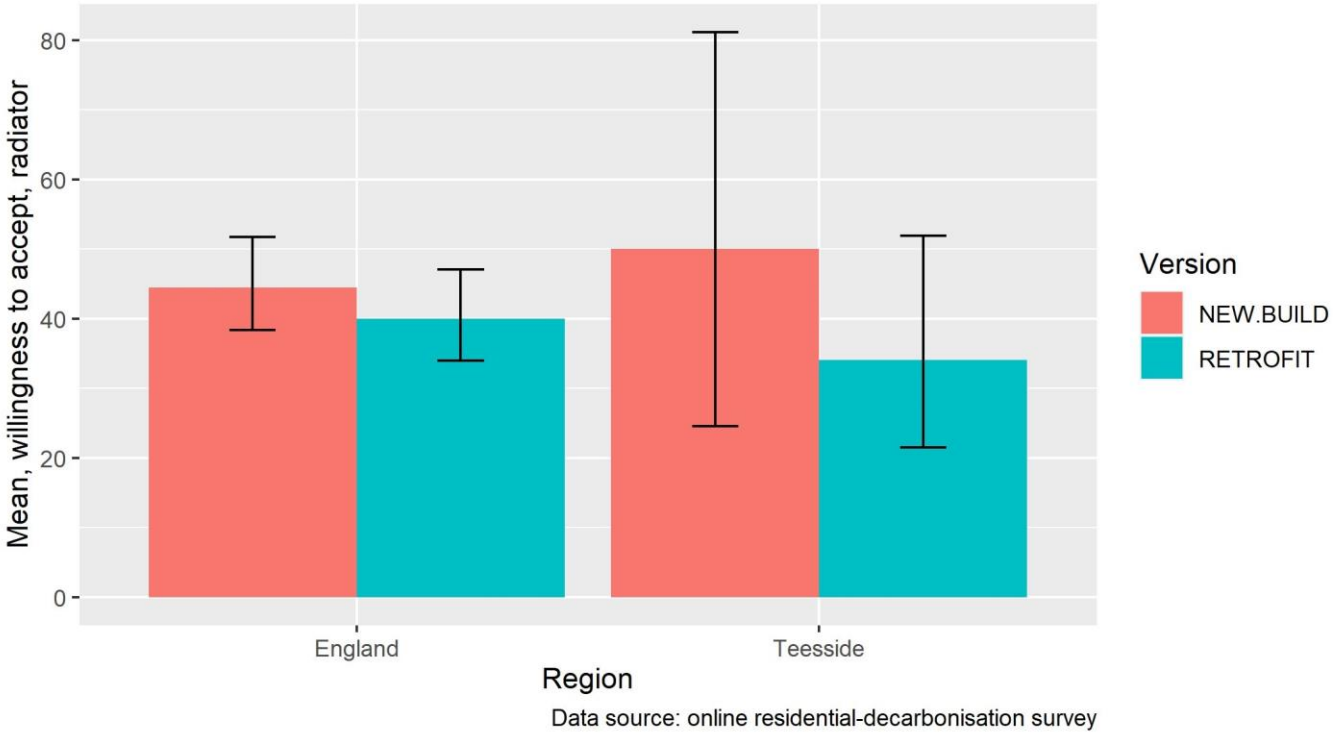
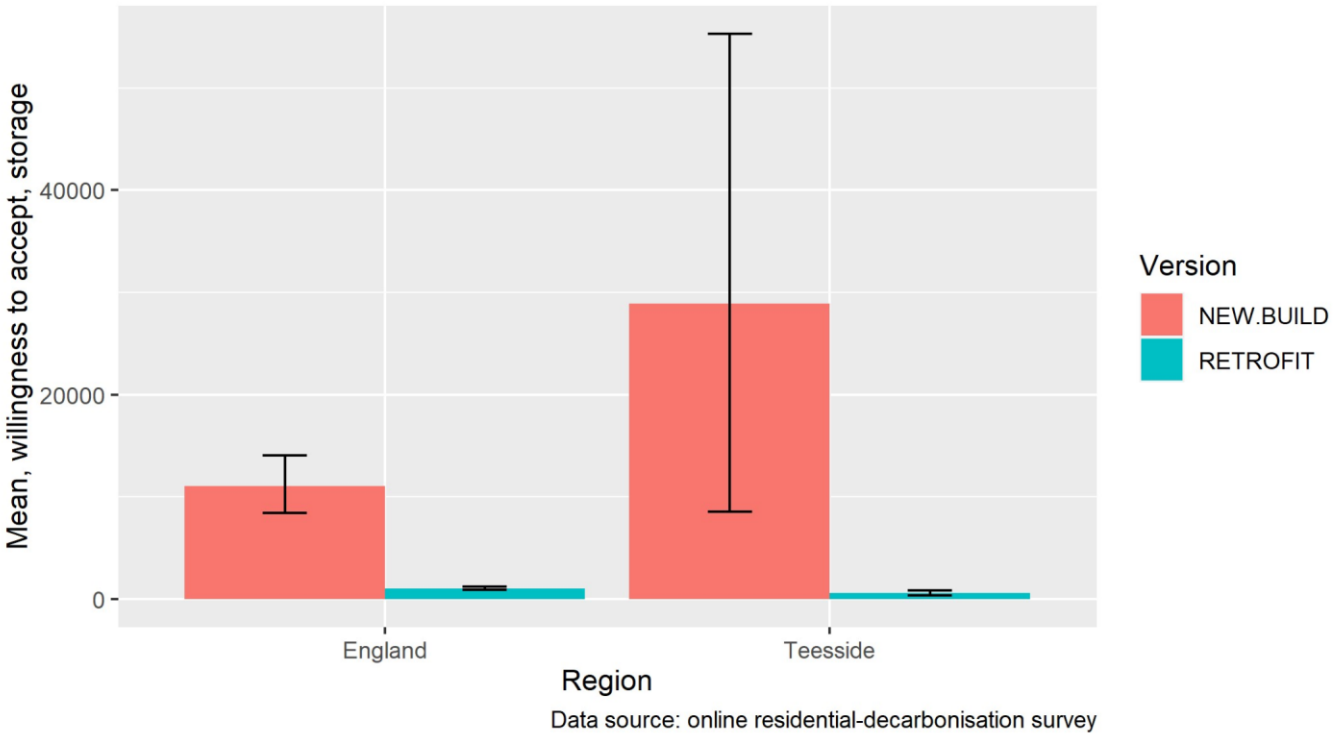


Owner



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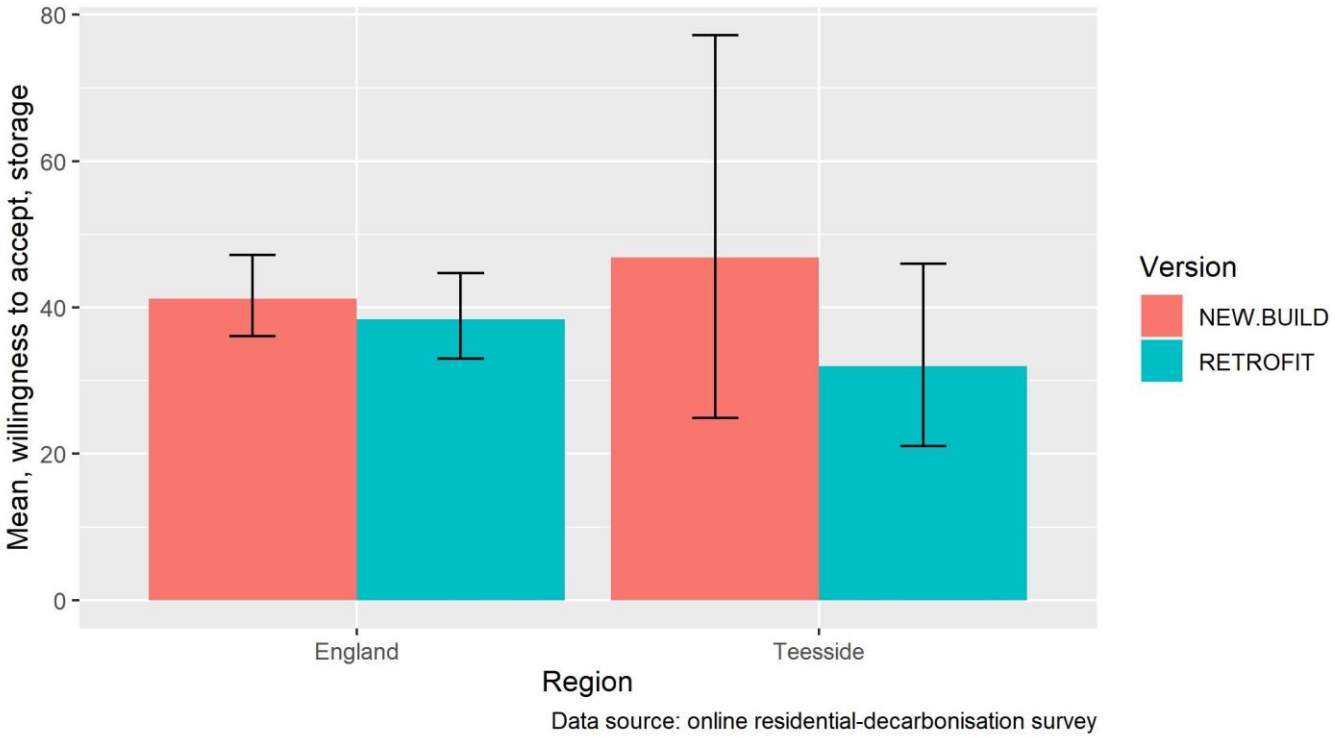
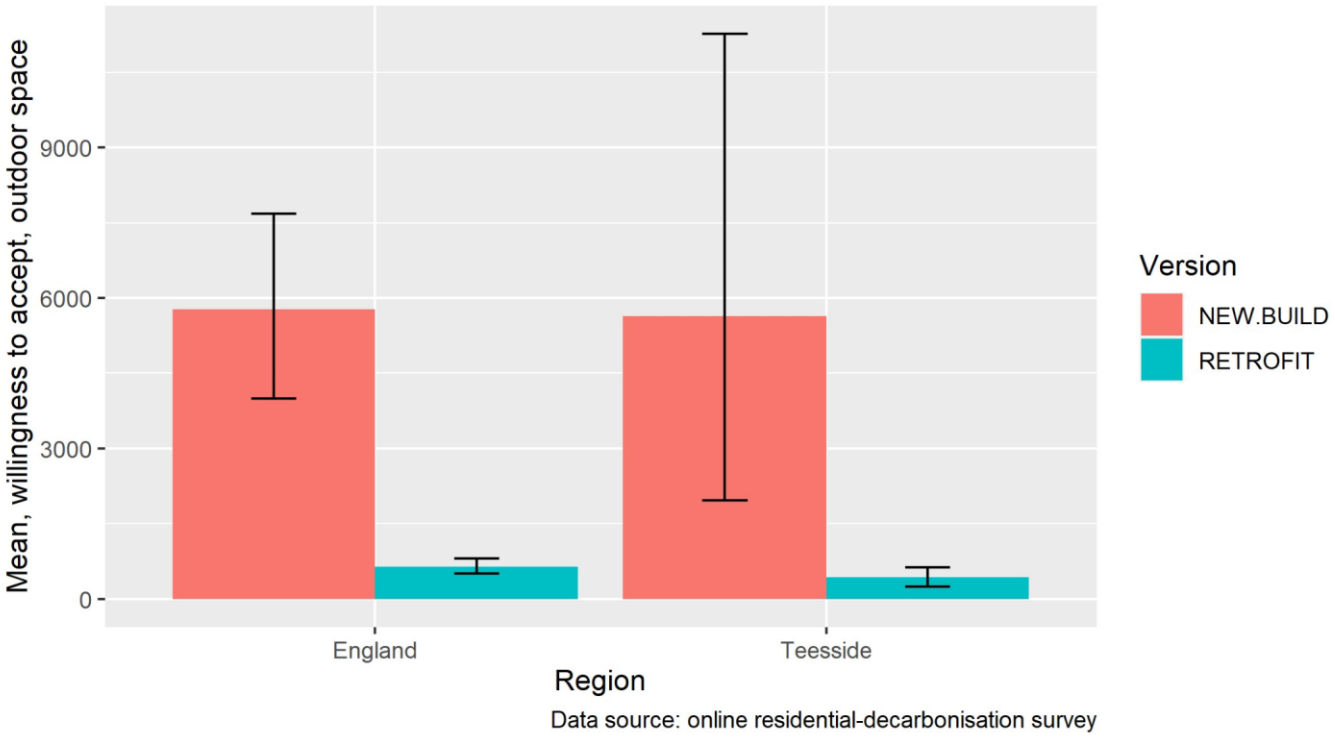
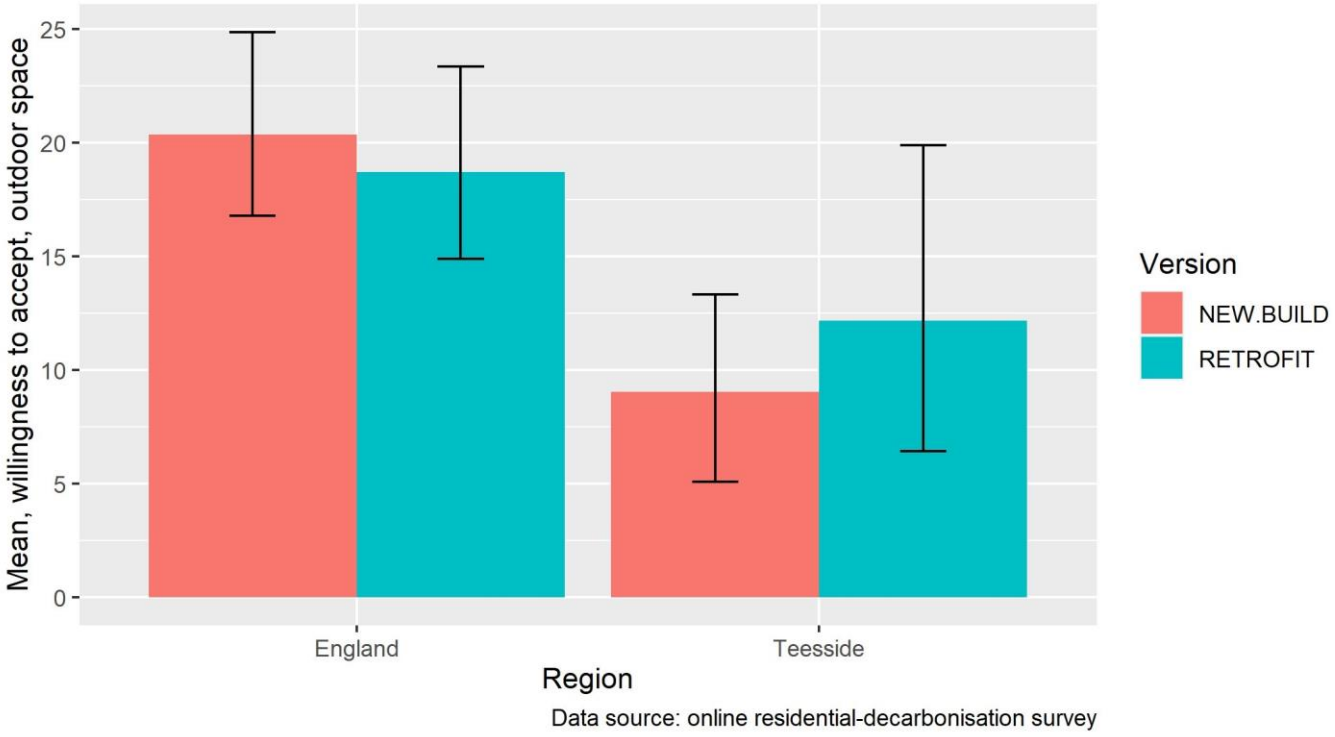


Owner

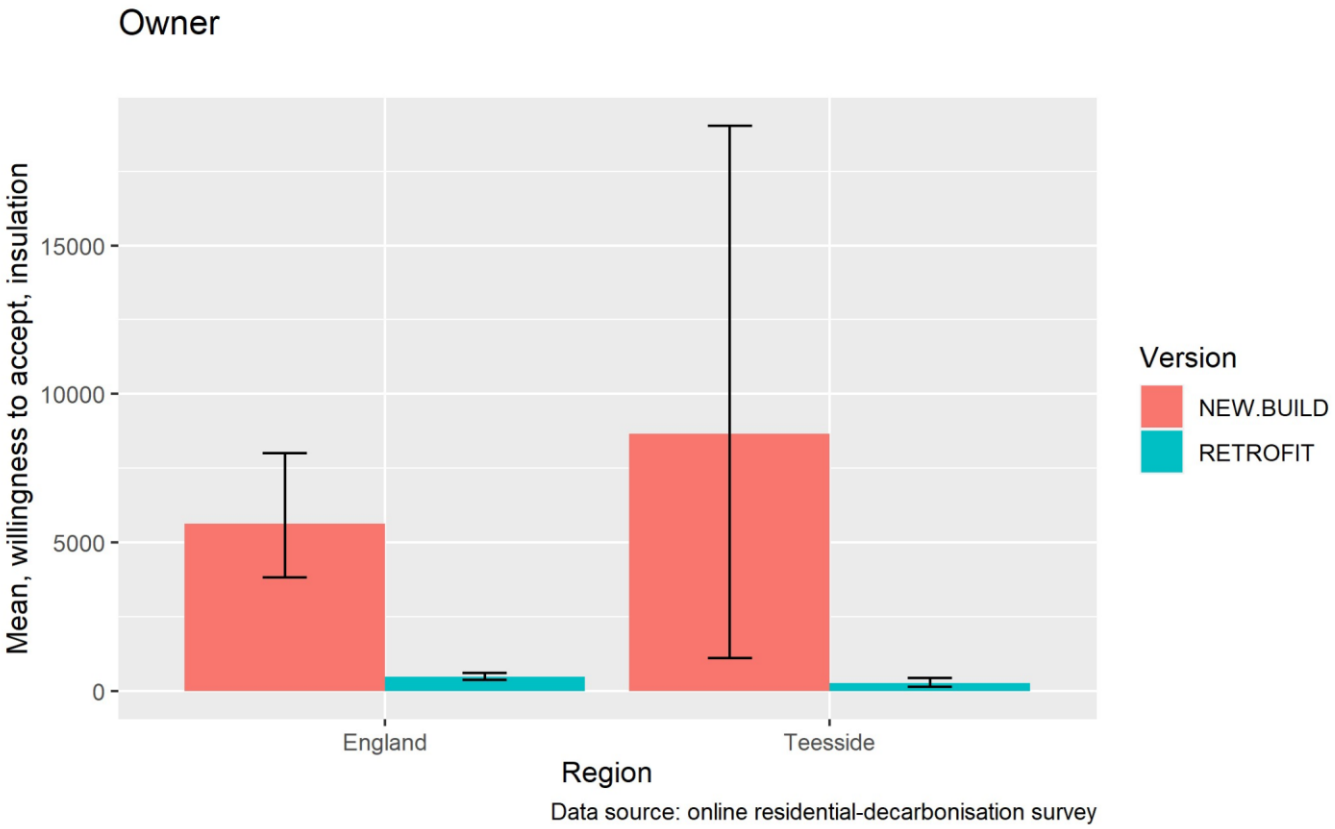


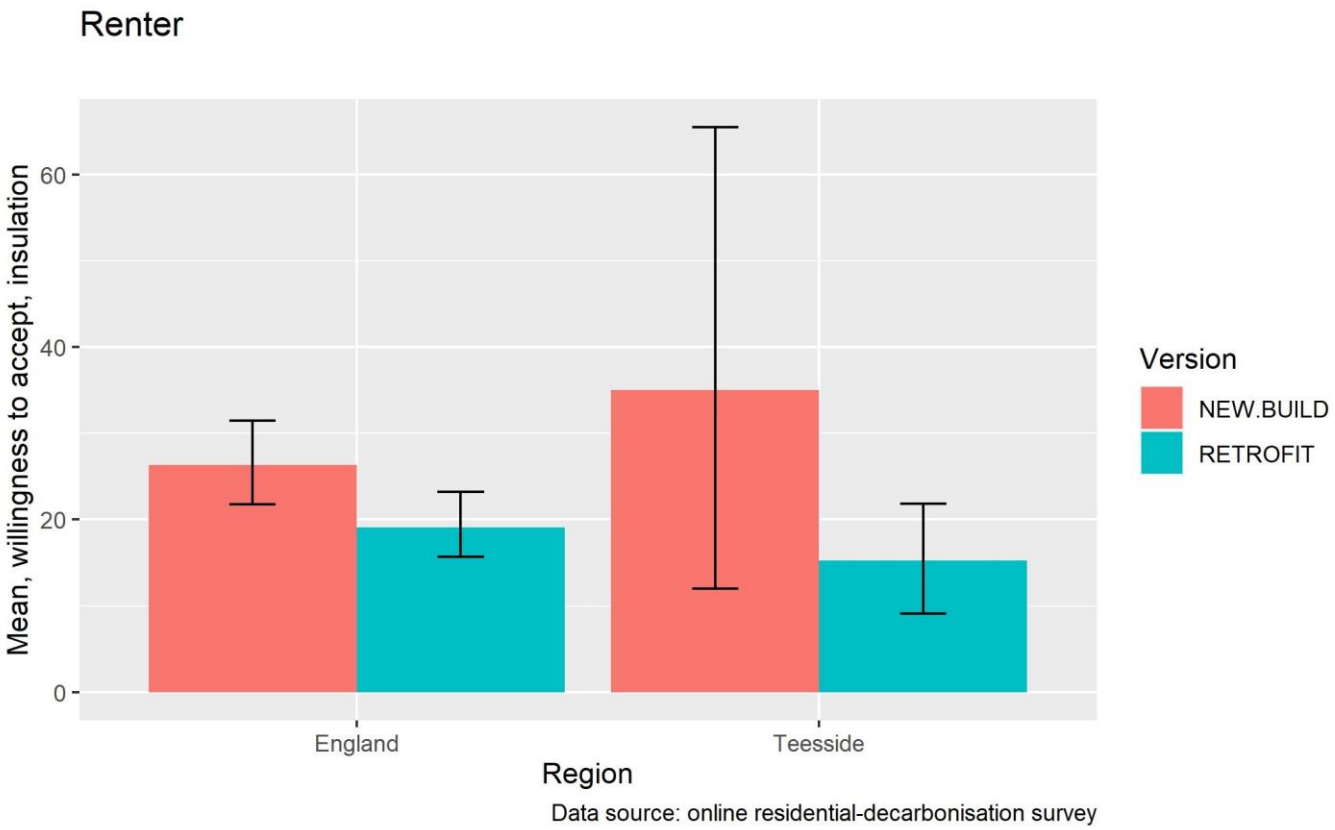
Data source: online residential-decarbonisation survey

Renter

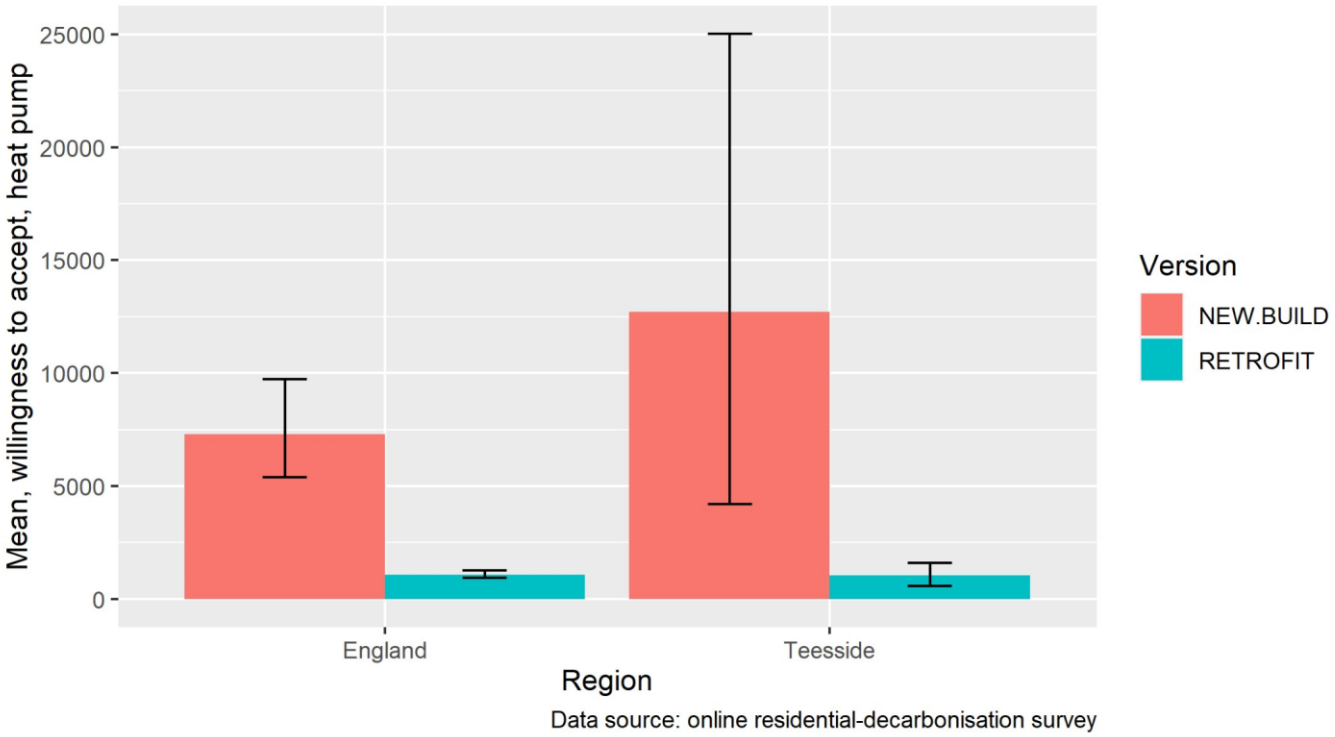


Data source: online residential-decarbonisation survey


Owner
Mean, willingness to accept, insulation
15000
10000
5000
0
England
Teesside
Region
Version
NEW.BUILD
RETROFIT
Data source: online residential-decarbonisation survey

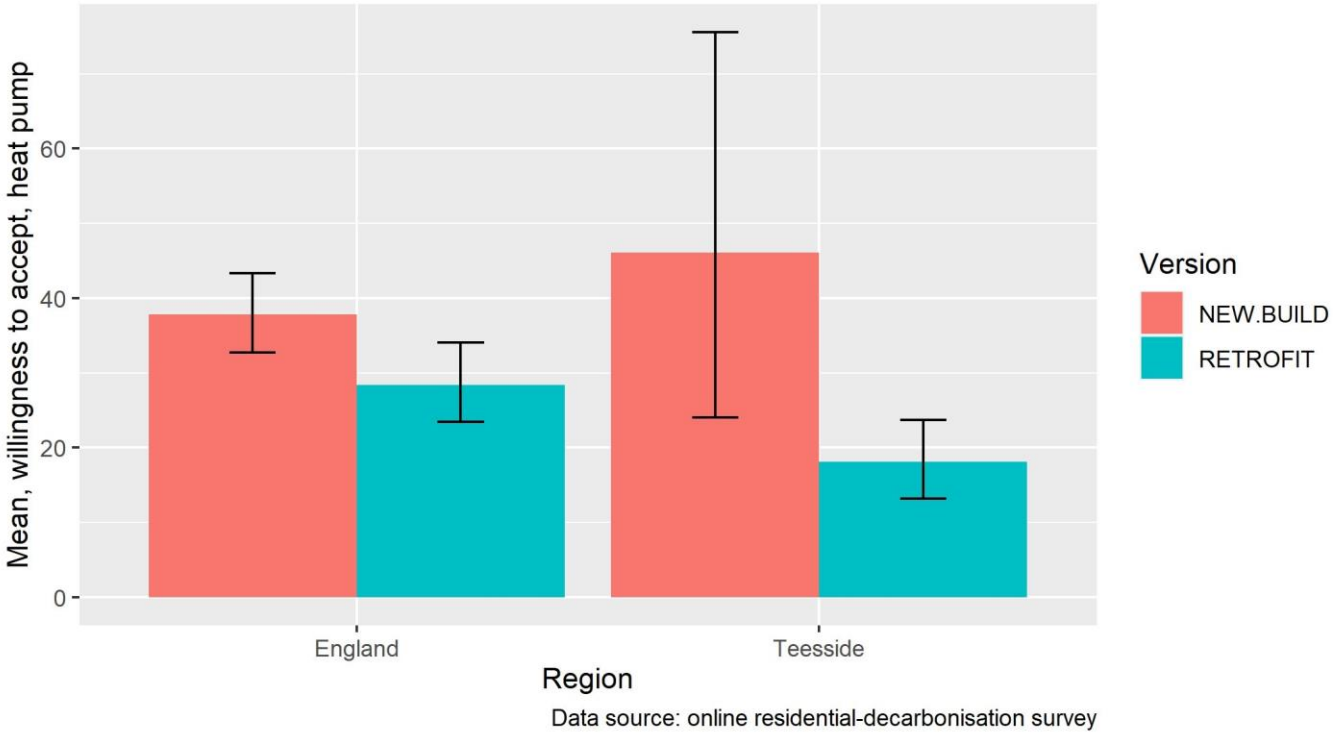

Renter
Mean, willingness to accept, insulation
60
40
20
0
England
Teesside
Region
Version
NEW.BUILD
RETROFIT
Data source: online residential-decarbonisation survey

Owner



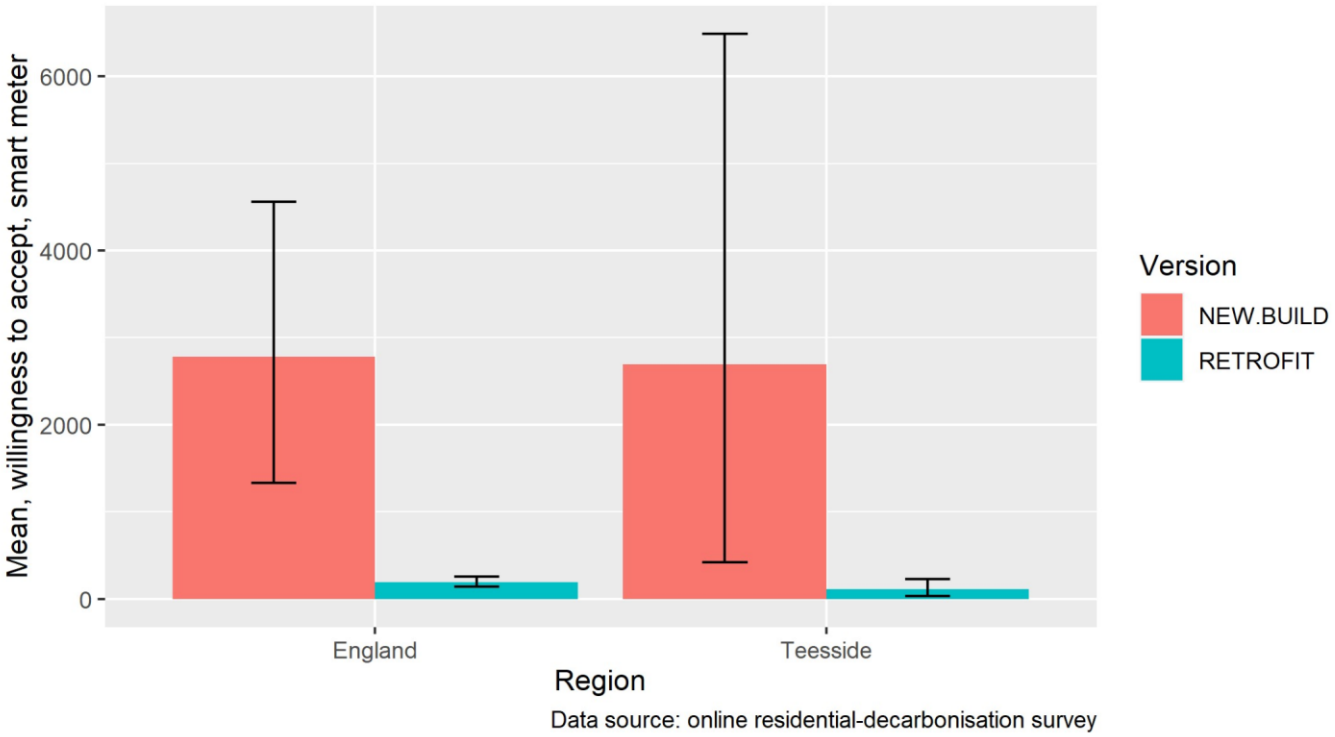
Data source: online residential-decarbonisation survey

Renter



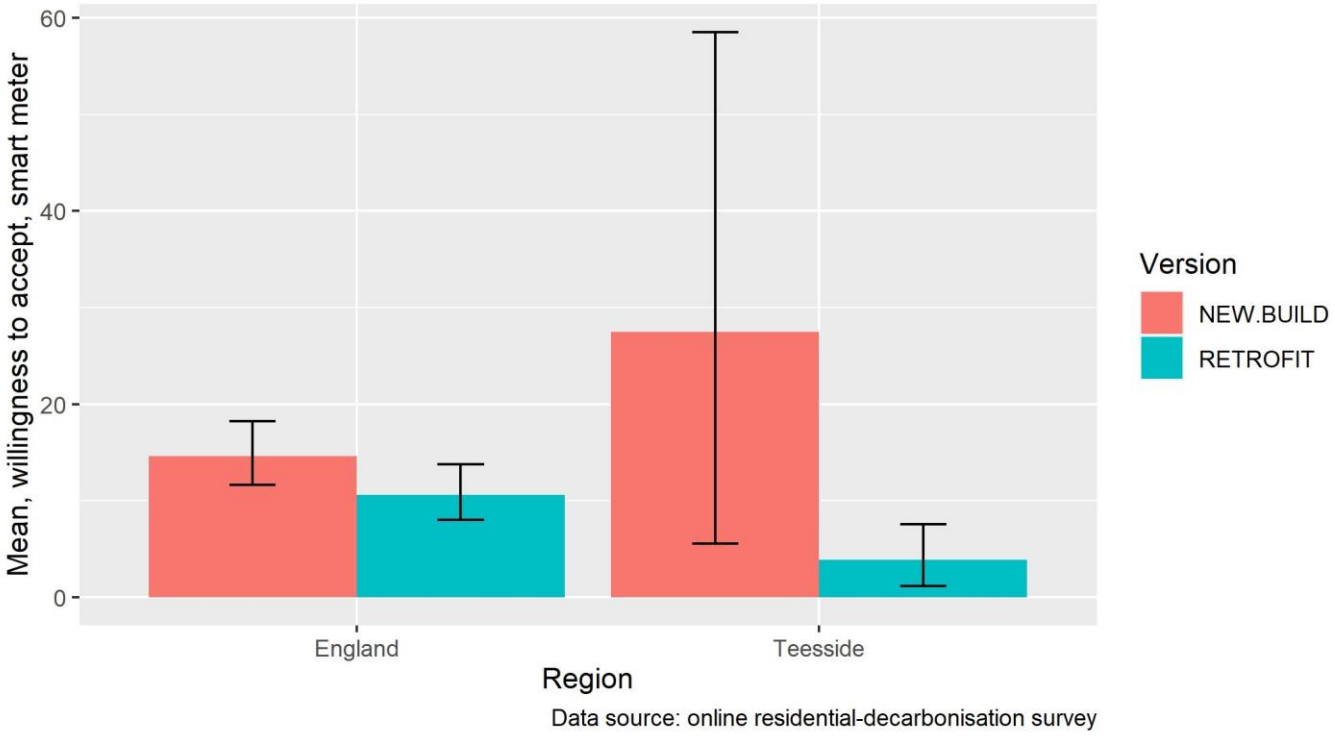
Data source: online residential-decarbonisation survey

Owner

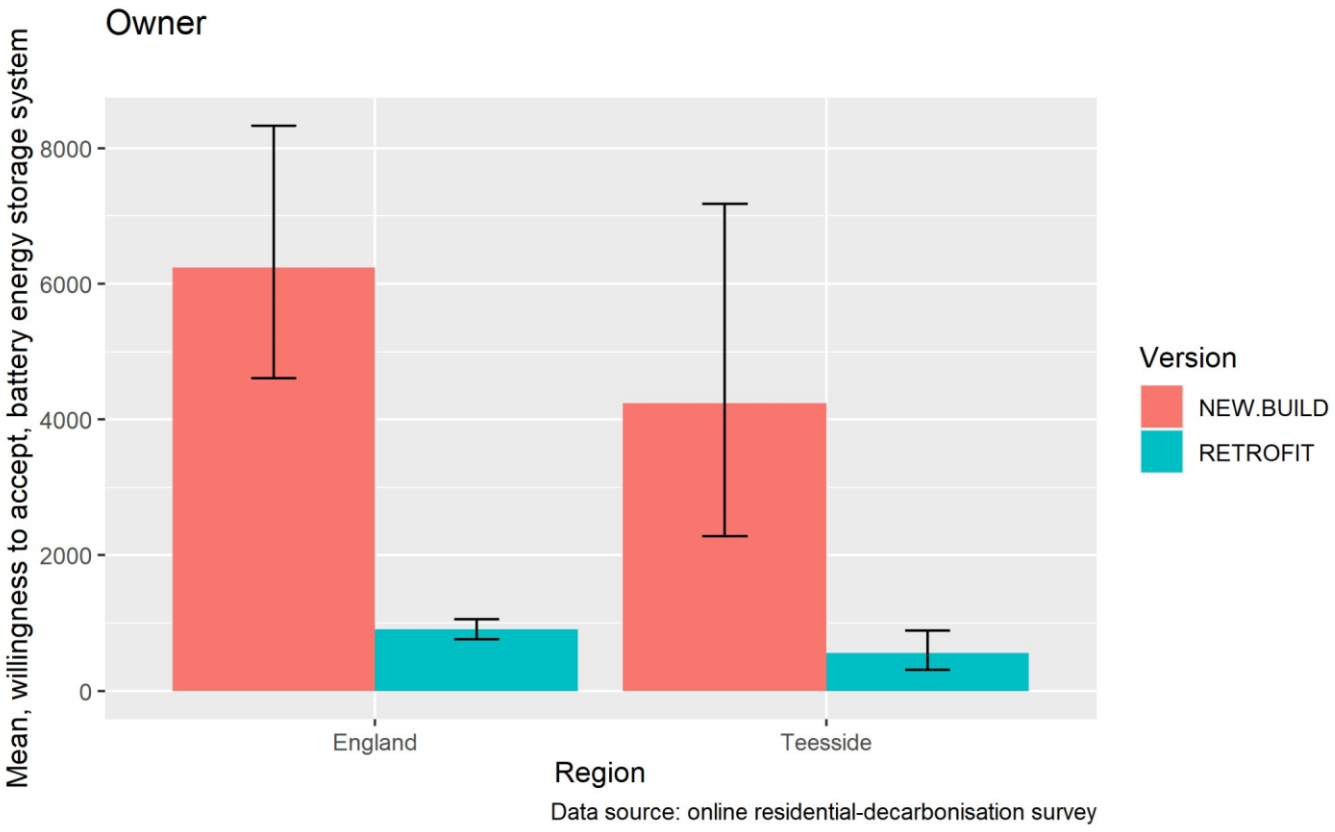


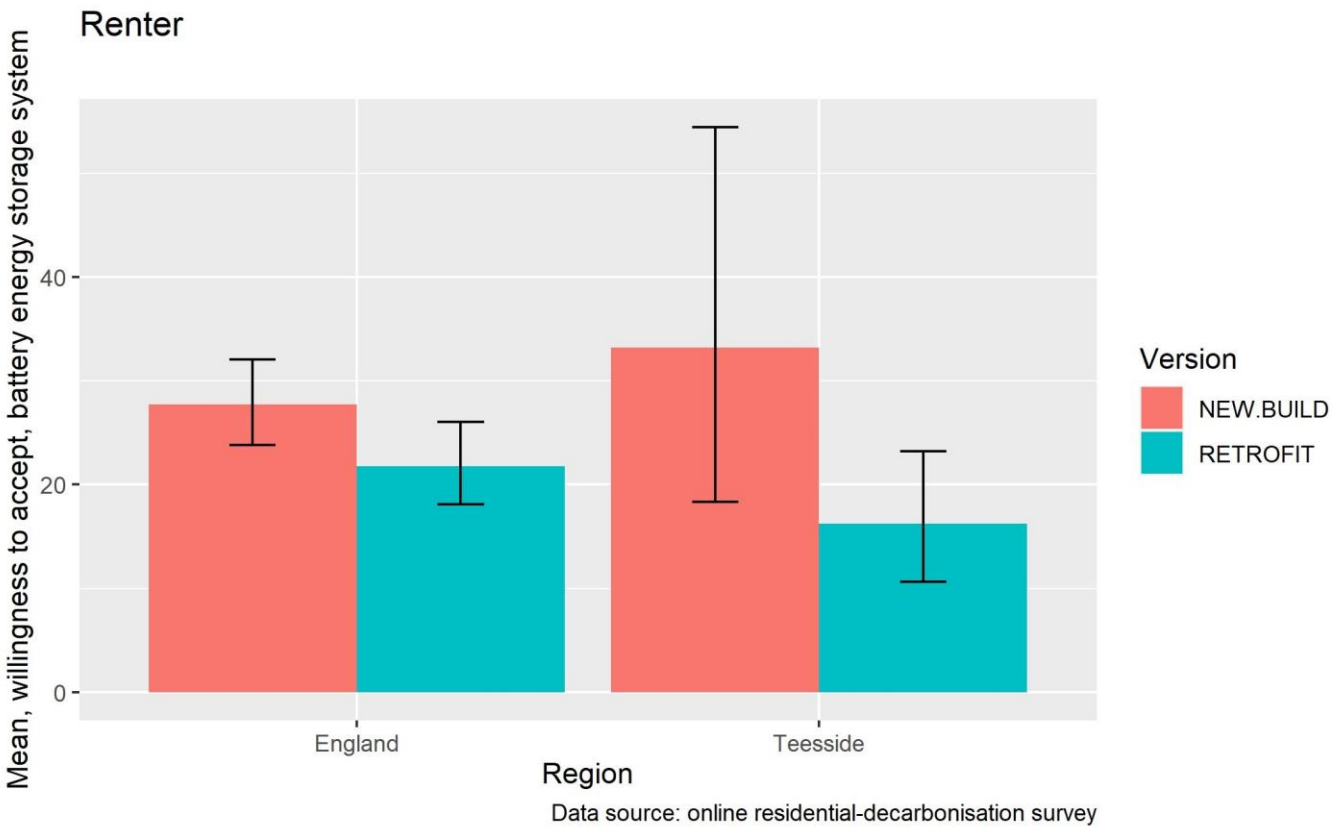
Data source: online residential-decarbonisation survey

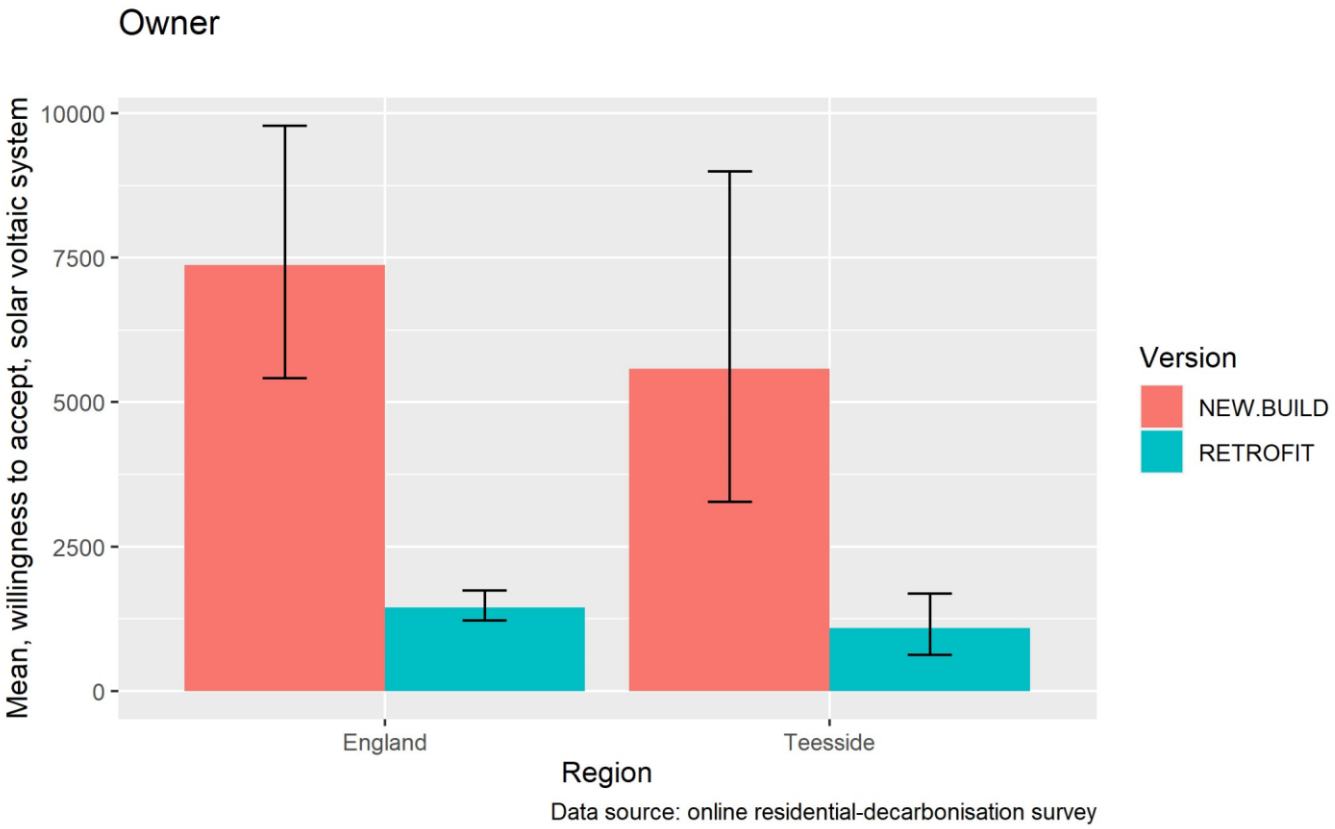
Renter

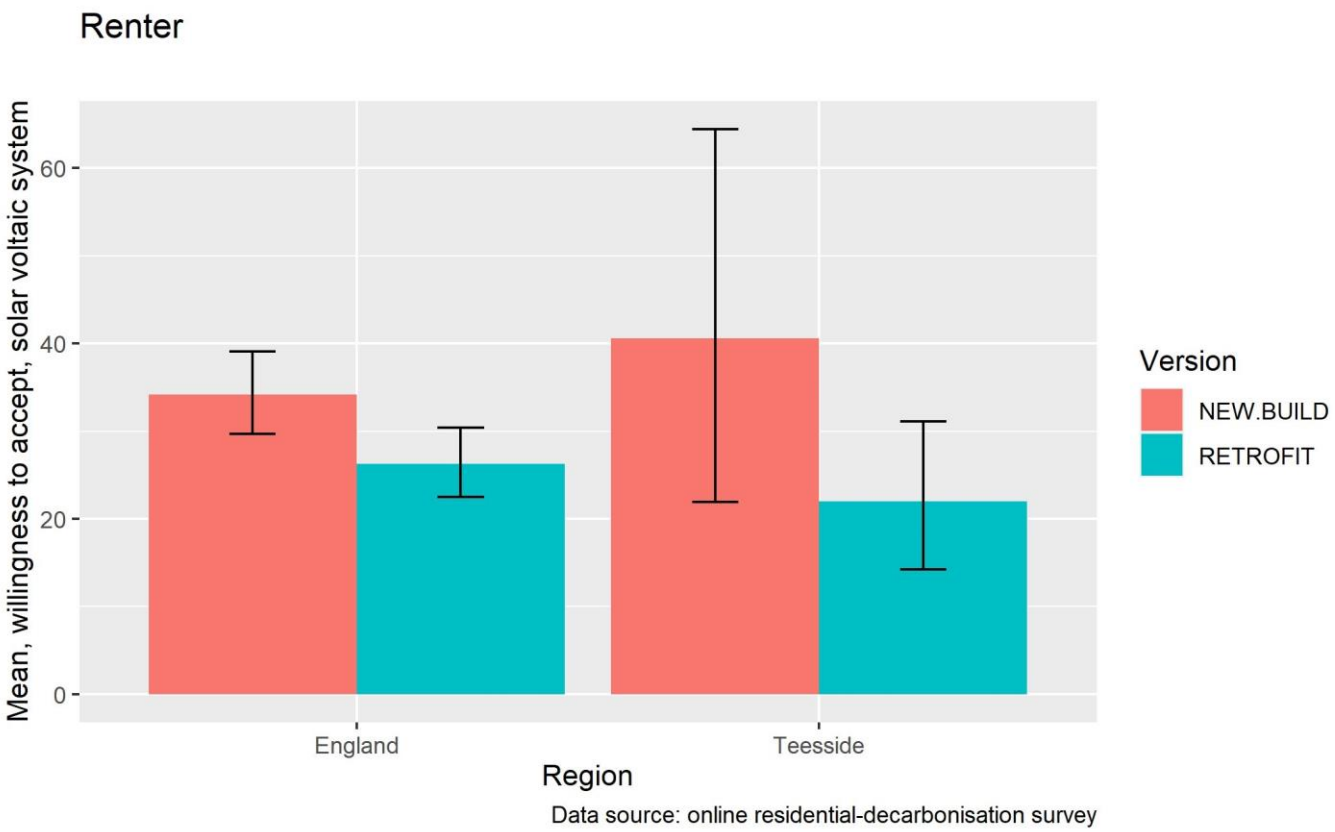


Data source: online residential-decarbonisation survey


Owner
Mean, willingness to accept, battery energy storage system
8000
6000
4000
2000
0
England
Teesside
Region
Version
NEW.BUILD
RETROFIT
Data source: online residential-decarbonisation survey


Renter
Mean, willingness to accept, battery energy storage system
40
20
0
England
Teesside
Region
Version
NEW.BUILD
RETROFIT
Data source: online residential-decarbonisation survey


Owner
Mean, willingness to accept, solar voltaic system
10000
7500
5000
2500
0
England
Teesside
Region
Version
NEW.BUILD
RETROFIT
Data source: online residential-decarbonisation survey


Renter
Mean, willingness to accept, solar voltaic system
60
40
20
0
England
Teesside
Region
Version
NEW.BUILD
RETROFIT
Data source: online residential-decarbonisation survey