Conference Paper

Stakeholder relationships towards influencing new zero carbon house building in the UK

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Stakeholder Relationships Towards Influencing New Zero Carbon House Building in the UK

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Abstract—**This paper examines the attitudes of house builders, house buyers and government officials and the perceptions of each group view on the future low or zero-carbon house building. From this analysis, possible hurdles in the forwarding of the development process in this field can be identified and possibly overcome.**

Keywords—zero-carbon house; carbon emission; climate change; energy efficiency

I. INTRODUCTION

UK housing carbon emissions make up 27% of the total UK carbon emissions [1]. If the UK is to achieve its 80% carbon reduction target by 2050 [2] then housing will have to play a part in the overall strategy as it currently is the largest contributor, around one third [1] of the UK's total emissions [3]. UK energy policy will have to make housing more sustainable which will involve the building of new sustainable housing and the conversion of existing housing stock. Low or zero Carbon housing could mean, for example, the addition of renewable energy features such as photovoltaic panels, solar thermal panels or wind turbines connected with battery storage within a smart grid system linked with labouring properties [4]. This could also mean the installation of energy saving measures such as high degrees of insulation, triple glazing and energy saving appliances. The likelihood of this low or zero-carbon housing being developed will depend on the appetite and views of several different stakeholders.

There is a chronic shortage of housing in the UK [5]. Housing supply is not keeping up with additional demand generated by rising life expectancy, immigration and the growing number of one-person households. The government proposed a fast-track new house building programme with a target of 1 million new homes to be constructed by 2020 [6]. Put into the perspective of the graph below showing historic house building in the UK, this is a significant increase on past house building policy.

Whilst committing to house building, the government have also committed to reducing the UK's carbon dioxide emissions by 80% on 1990 values [7]. Part of this commitment, if it is to be achieved, would have to be a significant reduction of the amount of primary fossil fuel energy used in the housing stock. Thus, any proposed new house building development will pose a significant challenge to achieving these two conflicting commitments in an affordable way. This then is a real and timely challenge faced by housing developers around the UK as well as the rest of the developed world.

The likelihood of low or zero-carbon housing being developed will depend on the appetite and views of several different stakeholders and an understanding and recognition of these opinions amongst the parties. In order to maximise the optimisation and success of any sustainable housing project, the views of all the stakeholders involved must first be identified and analysed.

Economically speaking, creating zero carbon housing is akin to an upfront financial investment that will save money over the lifetime of the building. The cost of this additional investment when purchasing a property may well be only a very small percentage of the overall cost, however because of the high cost of housing in the UK with a current average house price £234,794 [8] this may represent a significant cost. This perceived additional cost may represent a significant hurdle in the motivation of developers, and particularly their views on what house buyers will desire, and this paper looks to address any imbalance.
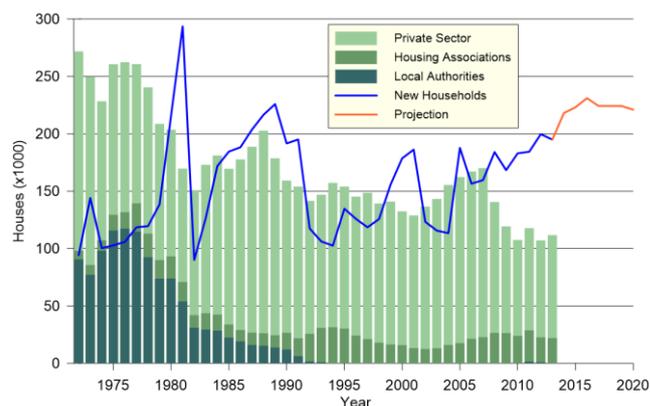

Fig. 1. Gap between new household requirements (line) and new house building (block); data from [4].

The goal of this paper is to understand and analyse views of different stakeholders involved in the house building industry and ascertain the importance and weighting each group put on views affecting the future building of low or zero-carbon house building. From this analysis, possible hurdles in the forwarding of the development process in this field can be identified and possibly overcome. Opinions of how each stakeholder group perceives the views of other groups (i.e. a house builders' perception of the opinions of the people who buy their houses)

will be compared with what they actually think and any differences explored. Consciences views among all stakeholder groups can be identified and analysed. Ultimately the market, government and end users will decide the success or failure of any sustainable housing scheme. This research will measure, quantify and compare stakeholders opinions and crucially identify any anomalies in perception between stakeholder groups that may intern lead to insights into barriers stopping the role out of low or zero-carbon housing.

II. METHODOLOGY

A. The Drivers of Low Carbon Housing

Osmani and O'Reilly [9] argued that there are three drivers of low carbon housing: Business, Culture and Legislative and as such three representative key groups have been identified namely (1) housing developers (Business), (2) the general house buying public (Culture), and (3) local and national government representatives (Legislative).

This research adopted a twofold approach consisting of a general survey where respondents from each set would give their views numerically from 1 to 10 about a range of questions to find their general perceptions and then a more in-depth interview where open questions were asked and the responses explored. The raw data from the survey questionnaires and interviews were then analysed using classical grounded theory. Learning and understanding the differences between grounded theories methodologies can be as much a learning of one's own research philosophy, and this philosophy is often the deciding factor in methodology selection [10]. The CGT (Classic Grounded Theory) methodology has its grounding in the original work of Glaser and Strauss [11], [12]. CGT was used to let theory emerge naturally from data and has been used successfully in other similar studies such as Energy sustainable communities: Environmental psychological investigations [13].

Stakeholders were asked a number of questions to gauge their views on a range of important and relevant matters. This was done anonymously. Views were recorded numerically from 1 to 10 i.e. 10 agree strongly, 1 strongly disagree and then analysed to gain a picture of the differing views amongst stakeholders. Additionally, open questions were then asked to drill down causal conditions. The views of the different stakeholders were then compared through constant comparative analysis for similarity and differences and any anomalies in perception identified between the groups based on the strategies of how core phenomenon in people decisions are formed and develop.

B. Theoretical sampling

A good range of random sample Influences from each stakeholder group was surveyed and polarising views investigated based on various concepts, strategies and identified core phenomenon. Some common questions were asked to each group of stakeholders whilst others only to one group. The different criterion within each group of stakeholders can fall into will be based on their employment position, education and age etc. There was a total of 34 respondents: 17 potential house buyers, 13 house builders' property developers and 4 members of local and national government who took part in the survey. In the questionnaire, the term solar panels will be used rather than use a catch all expression like reviewable energy or low carbon as this is what many people are familiar with and will give a good indicator of their feelings towards these issues.

Developers/House Builders. Developers will have to have the entrepreneurial appetite to take risks in constructing new forms of product that appeal to buyers: i.e. will what the developers construct be popular with buyers? Will they be able to sell any sustainable development quickly?

House Purchasers Buyers/Local Community/General Public. The views of a good spread of domestic property buyers and the community they will form were measured with regard to their views of renewable energy systems particularly how much sway or preference they would give to any such proposition given a choice. For instance, how much more would they be willing to spend upfront with possible savings during usage? With a possible long payback time, this may depend on the time they intend to stay in a property before moving on or their views on sustainability or climate change and the need to cut carbon emissions. Another aspect might be how open would a house buyer be to taking part or being involved in a community energy scheme?

Local Government/Urban Planners. The views of local government/urban planners are important as they may be able to influence local legislation regulations in the house building environment. They may include incentives or indeed disincentives to developers to encourage or discourage the building of low carbon housing and renewable energy schemes.

National Government. The national government may incentivise or discourage low carbon schemes as we have seen with recent discouragements such as with onshore wind farms [14] and large feed-in tariff cuts [15]. The encouragement of fracking [16] and subsidies to oil, coal and gas [17] additionally incentivises the use of fuels with high carbon imitations. On the other hand, encouragement to lower carbon imitations was given with measures such as Part L of the building regulations specifying increases in insulation and airtightness [18]. The Renewable Heat Incentive [15] also provided a financial incentive to promote the use of renewable heat and gives domestic users a feed-in tariff type payment for each kWh of low carbon heat produced. The Renewable Transport Fuel Obligation [19] was also devised to encourage the production of biofuels that do not damage the environment to the extents of fossil fuel alternatives.

C. The Survey

Score	1	2	3	4	5	6	7	8	9	10
Q										
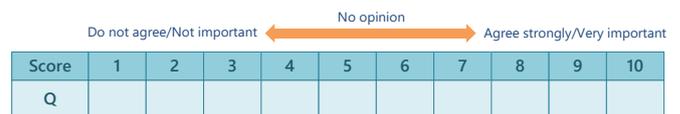
Fig. 2. Structure of the Survey score.

The survey consisted of two types of questionnaire. The first was where a set of questions which could be answered with a numerical score between 1 to 10. This gave an indication that the respondent either did not agree or the issue was not important to them (scoring towards 1), or they agreed strongly, or it was very important to the (scoring towards 10) as shown in Fig. 1 below. The questions were designed to gauge stakeholders

Members of the Public Average Overall Scores

0 Do not agree/Not important   No opinion   Agree strongly/Very important   10.0

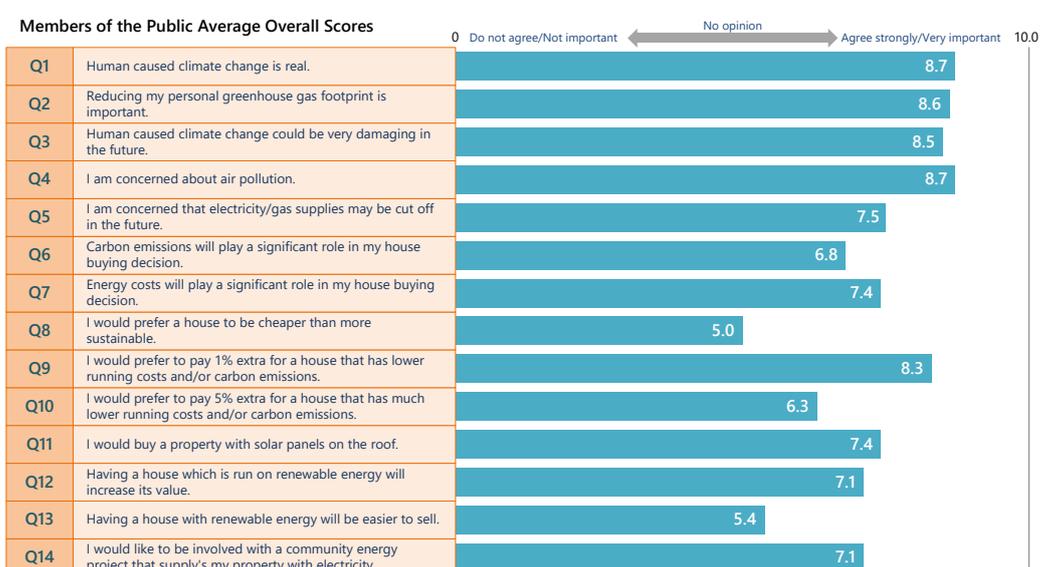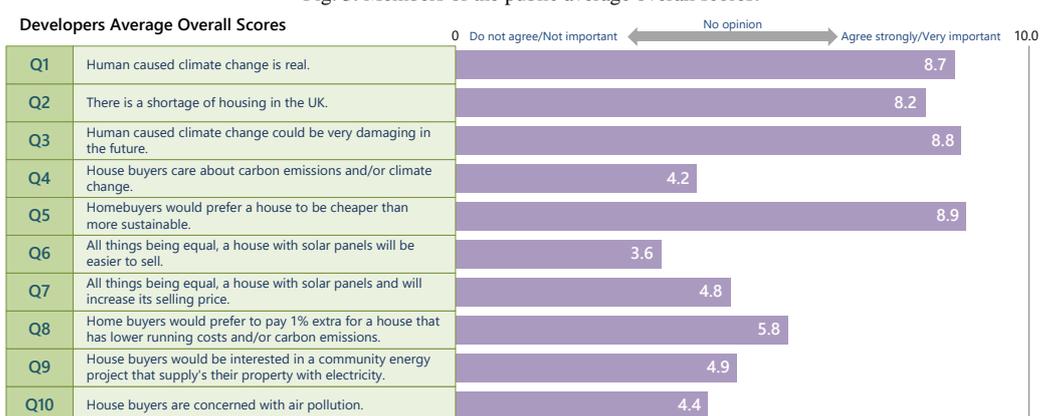|		Score
Q1	Human caused climate change is real.	8.7
Q2	Reducing my personal greenhouse gas footprint is important.	8.6
Q3	Human caused climate change could be very damaging in the future.	8.5
Q4	I am concerned about air pollution.	8.7
Q5	I am concerned that electricity/gas supplies may be cut off in the future.	7.5
Q6	Carbon emissions will play a significant role in my house buying decision.	6.8
Q7	Energy costs will play a significant role in my house buying decision.	7.4
Q8	I would prefer a house to be cheaper than more sustainable.	5.0
Q9	I would prefer to pay 1% extra for a house that has lower running costs and/or carbon emissions.	8.3
Q10	I would prefer to pay 5% extra for a house that has much lower running costs and/or carbon emissions.	6.3
Q11	I would buy a property with solar panels on the roof.	7.4
Q12	Having a house which is run on renewable energy will increase its value.	7.1
Q13	Having a house with renewable energy will be easier to sell.	5.4
Q14	I would like to be involved with a community energy project that supply's my property with electricity	7.1

Fig. 3. Members of the public average overall scores.

Developers Average Overall Scores

0 Do not agree/Not important   No opinion   Agree strongly/Very important   10.0

		Score
Q1	Human caused climate change is real.	8.7
Q2	There is a shortage of housing in the UK.	8.2
Q3	Human caused climate change could be very damaging in the future.	8.8
Q4	House buyers care about carbon emissions and/or climate change.	4.2
Q5	Homebuyers would prefer a house to be cheaper than more sustainable.	8.9
Q6	All things being equal, a house with solar panels will be easier to sell.	3.6
Q7	All things being equal, a house with solar panels and will increase its selling price.	4.8
Q8	Home buyers would prefer to pay 1% extra for a house that has lower running costs and/or carbon emissions.	5.8
Q9	House buyers would be interested in a community energy project that supply's their property with electricity.	4.9
Q10	House buyers are concerned with air pollution.	4.4

Fig. 4. Developers average overall scores.

Government Officials Average Overall Scores

0 Do not agree/Not important   No opinion   Agree strongly/Very important   10.0

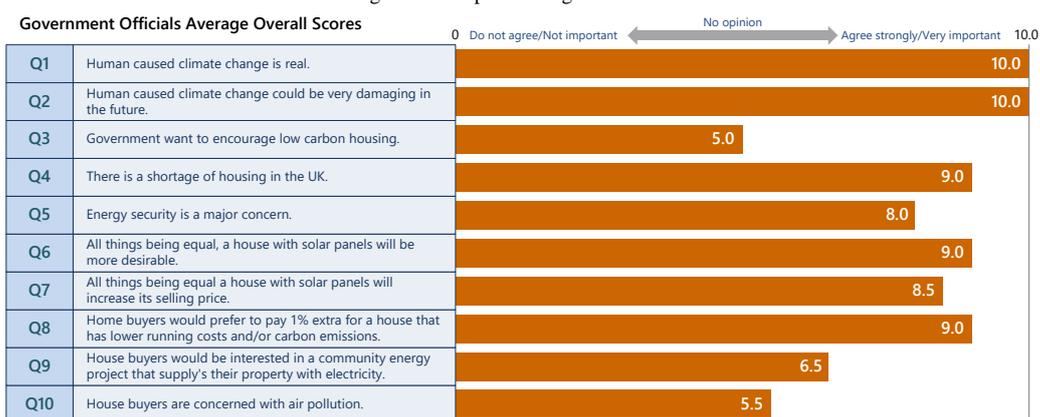|		Score
Q1	Human caused climate change is real.	10.0
Q2	Human caused climate change could be very damaging in the future.	10.0
Q3	Government want to encourage low carbon housing.	5.0
Q4	There is a shortage of housing in the UK.	9.0
Q5	Energy security is a major concern.	8.0
Q6	All things being equal, a house with solar panels will be more desirable.	9.0
Q7	All things being equal a house with solar panels will increase its selling price.	8.5
Q8	Home buyers would prefer to pay 1% extra for a house that has lower running costs and/or carbon emissions.	9.0
Q9	House buyers would be interested in a community energy project that supply's their property with electricity.	6.5
Q10	House buyers are concerned with air pollution.	5.5

Fig. 5. Government officials average overall scores.

attitudes around the key issues discussed and to identify patterns relevant to the research question. Each question was specifically formulated to ascertain the beliefs of the stakeholders in a format that would be conducive to constant comparison analysis once completed.

The second type of survey was a set of open questions. Open questions were asked to some respondents to expand on specific beliefs and identify key language used. As with any open questioning, this was a starting point where further questions could be asked depending on the responses received. More in-

depth focused opinions could be gauged, expanded upon and recorded using open questioning.

Sample of open questions asked:

- Do you believe humans are causing climate change- why? How did you find out about this? Depth of feeling? Expand/ explore.
- Are you worried about climate change? Why? How did you find out about this? What will happen if we carry on? Expand
- Would you have a solar panel on your roof? Why? How did you find out about this? Expand
- Can they type of house we buy stop climate change? Why? Expand.

III. RESULTS

There was a total of 34 respondents divided into three cohorts: 17 potential house buyers, 13 house builders' property developers and 4 members of local and national government who took part in the survey.

The average overall score on a survey question for each cohort is determined using the mean value equation as follows

$$\mu = \frac{1}{N}\sum_{i=1}^{N} x_i \qquad (1)$$

where μ is the mean value (average overall score) for each question; N is the number of respondents in each cohort; x_i is the score of an i-th respondent. This value is also used for analysis of probability density normal distribution $F(x)$.

- Age ranges of respondents were as follows: 0-25 (20%), 26-45 (36%), 46-65 (40%) and 65+ (4%)
- Professions of respondents where: Professional (56%), Manual/ clerical (40%), Retired (4%)
- Male (60%), Female (40%)

Table I shows samples of answers to open questions.

IV. DISCUSSION

Although the sample size was small, it was seen that saturation took place on many of the important points. The following, however, should take in the context that with government officials, for instance, there were only 4 respondents with one representing 25% of this particular group.

The obtained results are also analysed in terms of probability density normal distribution $F(x)$ using the following formula

$$F(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)^2}{2\sigma^2}} \qquad (2)$$

where x is the question score; σ is the standard deviation calculated as

$$\sigma = \sqrt{\frac{\sum_{i=1}^{N}(x_i - \mu)^2}{N-1}} \qquad (3)$$

TABLE I. IF YOU DO/DO NOT BELIEVE HUMANS ARE CAUSING CLIMATE CHANGE - WHY?

| |
|---|
| Doctor: Believe. Analysing information, get from media, scientific papers information, majority CO2 human activity. |
| Medic: Yes. Because there has been a dramatic change in average temperatures since humans when compared to slow historical changes. |
| Medic: Yes. Evidence of increasing CO2 levels in the atmosphere, rising temps/acidification in oceans, increase in extreme weather events, extension/death of species. |
| Anonymous: Do not believe. Because in the entire history of the world our lifetime is too short to know if its our impact on natural cycle. |
| Anonymous: Yes. Polluting the world, especially developing countries. |
| Anonymous: Yes. A lot of resources being used - cutting down trees - demand population increasing. |
| Doctor: It is likely humans are actively acceleration or creating a process from which rapid climate change is enabled. |
| Anonymous: There is good evidence to suggest climate change is happening and that industrialisation contributes to this. |
| Anonymous: Yes. Carbon exhausts from cars, wasting vs. recycling, all contribute to widening the hole in the ozone. |
| Anonymous: Yes. Scientific evidence, 95% of scientists (university and research). |
| Anonymous: Yes. Because of the way we live, too much rubbish (David Attenborough "Blue Planet"). |
| Anonymous: Yes. Because of plastic in the sea (TV "Blue Planet"). |
| Anonymous: Yes. Producing too much plastic. |
| Anonymous: Yes. Ice caps melting, climate change, carbon emissions. |
| Anonymous: Believe. Analysing information, majority of CO2 (Carbon) comes from human activity, from media, scientific. IPCC, respondent highly educated, articulate and knowledgeable. |
| Anonymous: Generally, believe. Industrial activity cause but naturally climate changes in the past – because of CO2 we produce more change, but volcano can bring more CO2 than humans in 1 year. Weather has always been changeable with passed ice ages, warm periods etc. This change of temperature acceleration due to human activity and so more dynamic that would otherwise be. Scientific evidence, 95% of scientists agree. Respondent highly educated and knowable. |
| Anonymous: Yes. Producing too much plastic – not sure how relates to climate change but the respondent feels strongly about it (because TV programme "Blue Planet") |
| Anonymous: Yes. Because there has been a dramatic change in average temperatures since humans when compared to slow historical changes. (Media). Evidence of increasing CO2 levels in the atmosphere, rising temps/acidification in oceans, increase in extreme weather events, extension/death of species. TV programmes, newspaper (Guardian) |
| Anonymous: Yes. Polluting the world, especially developing countries. TV/newspapers. A lot of resources being used - cutting down trees. Demand and population are increasing. It is likely humans are actively accelerating or creating a process from which rapid climate change is enabled. Carbon exhausts from cars, wasting vs. recycling, all contribute to widening the hole in the ozone |
| Anonymous: There is good evidence to suggest climate change is happening and that industrialisation contributes to this. Ice caps melting, climate change, carbon emissions. NASA. TV (Blue Planet)/newspaper. |
| Anonymous: No. This is made up by the government and scientists to get funding. The 97% consensus figure is proven wrong. From internet websites. Public being "fooled". Climate has always changed. |
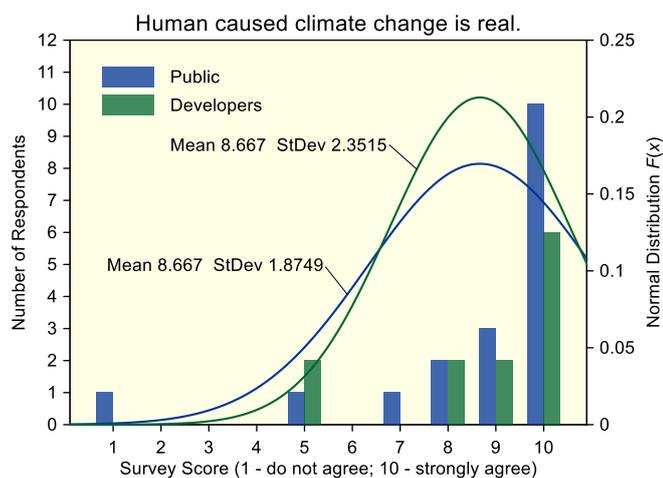
Fig. 6. A comparison of housing developers and the general public opinions "Human caused climate change is real".

As Fig. 6 illustrates, categories generally believed climate change by humans is real, i.e. "Human caused climate change is real" average scores where 8.7 in the general public sample, 8.7 for house developers and 10 for Government officials interviewed.

This is largely influenced by TV, radio and internet sources among the general public and developers but more influenced by climate science research from, for instance, NASA and the IPCC (Intergovernmental Panel on Climate Change) for government officials. Although this is a strong indication that opinions agree, this is still slightly less than the scientific opinion of a 97% agreement of climate scientists on human-caused global warming [20].

It was noted that, although government officials held this view, some (50%) were sceptical their government organisations all held this view when making housing policies with answering the question "Government want to encourage low carbon housing" with an average score of 5 (no opinion either way). It should be noted that environmental programmes such as David Attenborough's "Blue Planet" had a large influence of just over 15% of the general public respondents with a show broadcast the week before the survey on how humans are affecting the ocean. Some people (approx. 25% of general public and professionals) showed personal emotional influences such as family and "mother earth" type views for example "we are just tenants here and need to look after the earth for our children."

There were some exceptions (5% of the general public sample) who were climate change sceptics and did not believe humans were causing climate change and their main influence was specific websites on the internet and articles in newspapers such as the daily mail and reporters such as James Delingpole. One respondent who did not believe in human caused climate change answered with strong emotional vulgarity and bemusement at their distaste towards this question. It was noted that people who read the Guardian and were of higher education were likely to believe in human made climate change. The majority of respondents cited scientific arguments they had heard on TV, in newspapers, from friends and colleagues and on the radio in their answers.
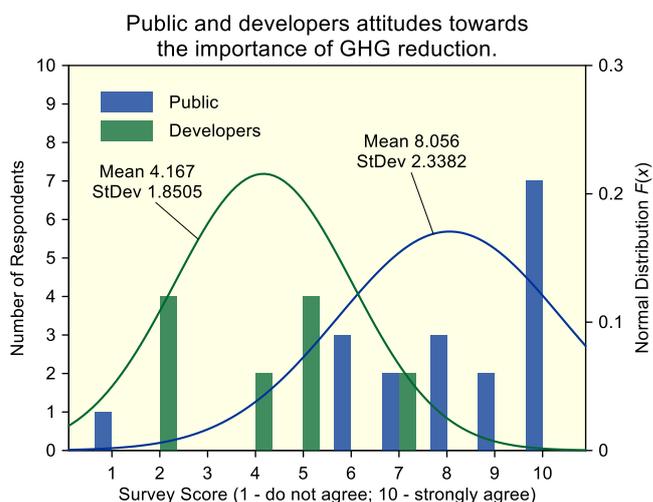

Fig. 7. A Comparison of the general public and house builder attitudes towards the importance of greenhouse gas emissions..

When house builders and developers were asked "House buyers care about carbon emissions and/or climate change" their average score was 4.2 (did not have an opinion or tended towards did not believe), however when the general public were asked "Reducing my personal greenhouse gas footprint is important" it was seen to be more important positive belief with an average score of 8.6. This has been illustrated in Fig. 7. This indicates that house builders underestimate the importance of this amongst its house buyers.
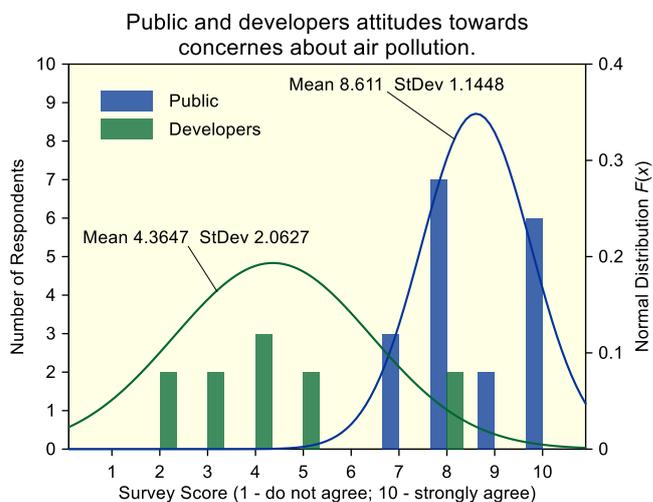

Fig. 8. A comparison of developers and public attitudes towards air pollution.

Developers also did not have an opinion that house buyers are too concerned with air pollution (average score 4.4) whilst the general public scored an average score of 8.7 for "I am concerned about air pollution" as shown in Fig. 8.

Developers again did not have an opinion or tended towards did not believe that "All things being equal, a house with solar panels will be easier to sell" with an average score of 3.6 and "All things being equal, a house with solar panels and will increase its selling price" with average score 4.8. Members of the public, on the other hand, said "I would buy a property with

solar panels on the roof" average score 7.4, and "Having a house with renewable energy will be easier to sell" scored 5.4.
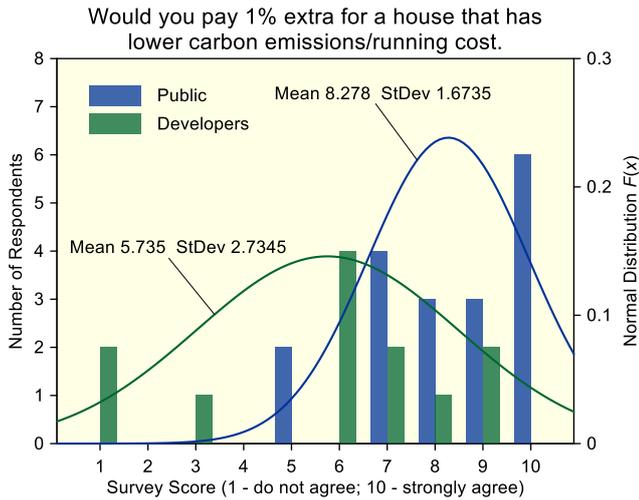

Fig. 9. A comparison of house buyers and housing developers views on if buyers would pay 1% extra for lower carbon emissions and running costs.

In terms of costs, home buyers said they "would prefer to pay 1% extra for a house that has lower running costs and/or carbon emissions" with an average score of 8.3 whilst developers scored lower for the question "Home buyers would prefer to pay 1% extra for a house that has lower running costs and/or carbon emissions." With an average of 5.8 as illustrated in Fig. 9. Although this does not state the magnitude of financial commitment or position of buyers, it is a useful comparison

Developers said they had no opinion on whether house buyers would be interested in a community energy project that supply their property with electricity with an average score of 4.9 whilst the general public scored an average 7.1 for the question "I would like to be involved with a community energy project that supplies my property with electricity."

There were no real correlations with age as there was a broad mix of answers with people of all ages from all groups.

Surprisingly, in the authors' opinion, the issues of cost did not appear frequently (16% of respondents). Anyone who mentioned cost assumed it would be more expensive than fossil fuels, but respondents did not know by how much. Energy security was not mentioned at all.

V. CONCLUSION

The three main conclusions can be seen from the dataset:

- Developers and house builders underestimate the general public attitudes and apatite towards sustainability and wanting to reduce climate change.
- The media (newspaper and TV news articles) strongly influence people attitudes regarding sustainability and climate change (both for and against).
- Environmental programmes such as David Attenborough's "Blue planet" have a large influence on viewer's perceptions towards sustainability.

This research indicates that if developers and house builders better understood house buyer's attitudes towards low carbon

housing, they would possibly be more likely to take the risk to cater to what was important to their customers. This could be seen as an opportunity for developers to brand as sustainable development and to build and market low carbon housing estates.

This research is important to Governments as it is the authors' belief that if politicians and political parties formulate policies that may seem to be unpopular, they will lose votes [21], [22] are less likely to be adopted and hence be shied away from. Because a large portion of general public respondents was open to sustainable issues, this research then indicates that voters would be sympathetic towards some sustainable policies towards housing.

The popular TV programme "Blue Planet" (BBC) seems to have created a wave of public opinion on the environmental issue of plastic in oceans. Respondents answers to survey questions indicated that the most powerful driver in motivating them to remember and take action on this subject was the images of sea creatures in distress. Lessons may be learned from this public motivator in enabling the rapid transition needed to low carbon. For some time after the programme, the author noted multiple references on radio, TV, internet and newspapers. This issue has been known about for several decades but did not play a big role in the wider public visibility. Upon the popularity of this subject, politicians have not been slow to adopt action from the top with the PM vowing to eliminate UK plastic waste by 2042 [23] and secretary of the environment Michael Gove making multiple statements. The issue of Climate change has far more serious consequences than plastic in our oceans, but during the interviews seemed to be held higher in the current public concessions.

In the future politicians of today may have to justify their decisions made now in the face of the known current 97% climate scientist consensus on consensus on human caused climate change [20]. It is the authors' belief that they will be seen to have not done enough and given some of the predictions of how catastrophic the consequences may be [24], [25] not doing enough now could prove ultimately to be the most unpopular path in the long run. It could be in the best interests to all to encourage popular science programmes to be made about climate change and the need to cut carbon emissions as this has been shown to have large influence on people's attitudes and may sway public opinion further and hence prompt political views in favour of adoption greater impacting sustainable policies.

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