# Are low-carbon innovations appealing? A typology of functional, symbolic, private and public attributes

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## 1.0 Introduction

Consumers contribute significantly to global $CO_2$ emission [1]. In the UK, transport is the largest contributor to GHG emissions (26% of total) with over half of this from passenger cars [2]. Approximately 38% of food waste can be attributed to consumers [3] and this represents a significant amount of embodied GHG emissions. Many innovations exist which offer consumers lower carbon alternatives to high emitting behaviours such as personal car use, heating homes, high meat diets and food waste yet they remain at the edges of market share. London has the largest car club in the UK but only 11% of car owners in inner London are members [4, 5]. Just over 5% of UK households own smart home devices such as washing machines or smart lighting [6].

Adoption of an innovation is dependent on whether its characteristics or attributes appeal to consumers [7, 8]. In his model of the innovation decision process Rogers [8] identifies five attributes which determine rates of diffusion: relative advantage, complexity, compatibility, trialability, and observability. In his technology acceptance model Davis [7] identifies two attributes key to technology diffusion: ease of use and ease of access. Despite insights from these models, there remains a lack of dedicated empirical research focussed on the novel attributes of low carbon innovations. Empirical studies, particularly those within environmental psychology, have a tendency to compare single innovations (such as electric vehicles), against incumbent technologies (conventionally fuelled vehicles). They focus on the private benefits of the incumbent technology (such as costs and performance) with the environmental benefits of the lower carbon alternative (such as lower emissions) [9, 10]. Low carbon innovations offer consumers a wide range of attributes not captured in such studies. Electric vehicles for example provide benefits beyond reduced emissions, including options for integration into the smart grid [11], independence from petroleum companies [12, 13], and strong environmental symbolism [14].

There are many different types of attribute [15, 16]. In his ring mode Levitt [16] identifies three different layers: primary, secondary and tertiary. Primary attributes relate to the product's core benefit or purpose. A private vehicle for example offers personal mobility. This feature is indistinctive across all makes and models of vehicle. Secondary attributes are

more distinctive [15]. They tend to be more symbolic in that their value is perceived by the consumer [17]. For private vehicles secondary attributes include quality, performance, style and image. Tertiary attributes are unique and novel [16, 18]. Autonomous vehicles for example offer many tertiary attributes including freeing up people's time from driving [19, 20]. This model has many applications particularly within the field of marketing.

The importance of more socially orientated, public domain attributes is a strong feature of a framework identified by Axsen and Kurani [12]. Using a 2 x 2 matrix they distinguish between four domains: private functional, private symbolic, public functional and public symbolic [12, 21]. Applying this to the appeal of electric hybrid vehicles in the workplace (and as an alternative to private car use) Axsen and Kurani [12] find that users are attracted to a wide range of private and public, functional and symbolic attributes. In this study we use the Axsen and Kurani [12] framing to identify the important attributes of a wider range of low carbon innovations. Moving beyond mobility we explore the appealing attributes of low carbon innovations within food, homes and energy sectors.

Low carbon innovations already exist in key consumer sectors. In separate research we identify over 35 different consumer facing low carbon innovations within mobility, food, homes and energy sectors [22]. To examine the detailed perceptions of consumers we concentrate on 12 consumer-facing low carbon innovations. All 12 are alternatives to mainstream incumbents in their sector. They also represent alternative models of consumption: service based provision versus ownership, and centralised business to consumer (b2c) versus peer to peer (p2p).

Our over-arching research question is "what is the appeal of low carbon innovations with novel attributes which offer alternatives to mainstream practices?" Secondary research questions relate to identifying the range of attributes, the relative appeal of attributes across innovations within specific sectors and retail models, and potential sources of distinctive value relative to mainstream practices.

To address these questions we use repertory grid method. This methodology combines structured elicitation with statistical methods. It enables in-depth, semi-structured interviews through which participants are guided through specific exercises. This approach is essential when participants are required to discuss unfamiliar concepts or in our case, low carbon innovations which have low presence in the wider marketplace. We apply this method using 67 people living in a representative city in the UK (Norwich).

## 2.0 Analytical framework

### *2.1 Four domains of attributes*

Axsen and Kurani [12] identify a two-by-two dimensional typology of attributes: private functional, public functional, private symbolic, public symbolic (Figure 1).

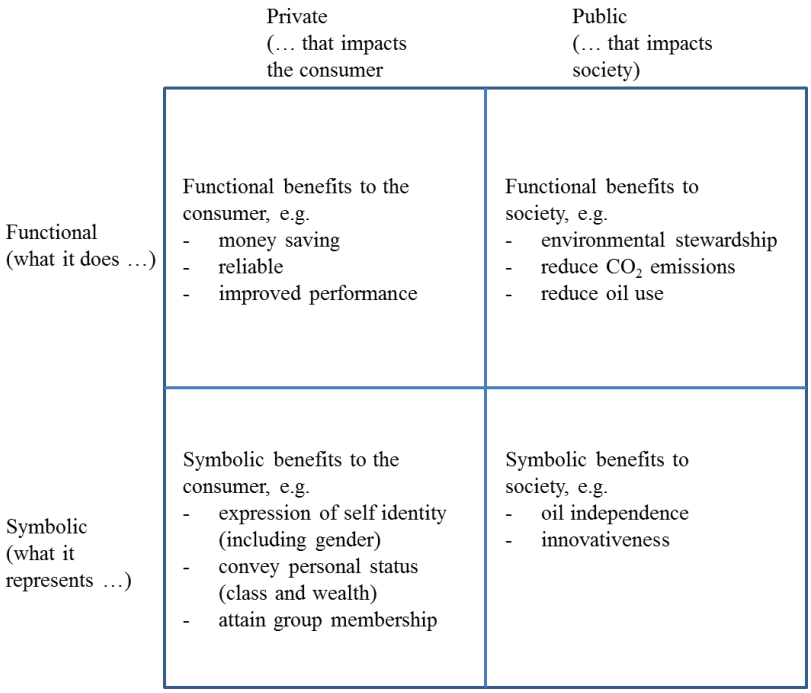



Figure 1 – the four domains of attributes, as they relate to electric vehicles (adapted from Sovacool and Axsen [21], Axsen and Kurani [12]

Private functional attributes impact and benefit the consumer. From a more recent study into electric vehicles Sovacool and Axsen [21] find they strongly relate to what cars do for individual car drivers. Car drivers show strong preferences for cost [21] savings, reliability, performance, flexibility and familiarity. These attributes are widely acknowledged as important antecedents to choice [7, 8, 23]. They feature heavily in transport literatures as key determinants of both vehicle type and choice of mode [9, 24].

Private symbolic attributes relate to what cars represent for car drivers. They relate to private identity and hold symbolic value related to expressions of self-identity, personal status and group membership. Driving itself is an expressive activity where the type of car and manner in which it is driven gives the driver an opportunity to express individuality and autonomy [25]. For many drivers their choice of car reflects feelings of sensation, power and superiority [26]. In contrast electric vehicles signal altruistic values and a greener social identity [10, 14, 27].

Public functional attributes are very different. They relate to what cars do for society as opposed to the individual. For some people cars are perceived as causing pollution, especially in densely populated areas [28]. For those people using an electric vehicle would represent a form of environmental stewardship. That is through their vehicle choice, drivers are able to become actively involved in protecting the environment, opting for fuel types that reduce air pollution, oil use and $CO_2$ emissions [21].

Public symbolic attributes symbolise or signal a collective, shared, or ‘social message’. Using an electric vehicle for example can signal to the petroleum industry that a driver seeks to be independent of transnational fuel suppliers [21]. This social signalling also relates to

other external groups or organisations such as automotive manufacturers or incumbents, where they have been hostile to innovations that threaten their core business strategy. Buying an electric vehicle can be a social indictment to traditional engineering principles and automotive manufacturing practices. Sovacool and Axsen [21] use the example of the Tesla car which has emerged as an automotive brand that directly symbolises a challenge to the structure and strategy of incumbent automakers.

*2.2 Low carbon innovations*

Low carbon innovations offer consumers an alternative to high carbon incumbent technologies or high carbon practices. In the mobility sector they challenge the incumbent model of car ownership and use [29-31]. They include innovations that offer alternative forms of, and alternatives to, auto-mobility. In the food sector low carbon innovations challenge livestock production, land use including intensive food production and transportation, and food waste. They include innovations that replace or reduce meat consumption, those that challenge the mainstream agricultural model of food production, promote producer to consumer relationships and those that reduce the demand for food [32-34]. In the homes sector low carbon innovations challenge energy waste related to limited user control and demand for space and materials. In energy use (on-demand) and supply to homes, low carbon innovations challenge models of centralised utility supplied electricity or gas. They include those that introduce new service providers, those that integrate consumers into the grid, and those that decentralise energy supply [35]. The sharing economy is a significant economic development and across all four sectors low carbon innovations exist which challenge the incumbent paradigm of exclusive ownership of assets [36]. They include business to consumer (b2c) and consumer to consumer, also known as peer to peer (p2p) business models [37, 38].

Table 1 –Low Carbon Innovations used in this study

| **sector (a)** | **Low carbon innovation *and description*** | **main incumbent (b)** | **service based provision (sb) or ownership (own) (c)** | **centralised retail (b2c) or sharing economy (p2p) (d)** | **UK market share (est.) (e)** | **potential for emissions reduction (f)** |
|---|---|---|---|---|---|---|
| **mobility** | car clubs *access to fleets of vehicles on a pay per use basis* | private car use | sb | b2c | .4 – 8% | reduced private vkms [39] |
| | shared taxi *cars or minivans with multiple passengers on similar routes* | | sb | b2c | - | |
| | mobility as a service (MaaS) *access to a range of transport services through a digital platform* | | sb | b2c | <.1% | reduced congestion, pollution and traffic [40] |
| **food** | rooftop urban farming *fresh produce on supermarket rooftops which consumers can buy in the store below* | large scale food retailing and food waste | own | b2c | <.1% | reduced food miles, energy required to heat the building [41, 42] |
| | digital hubs for local food | | own | b2c | 0% | reduced food |

| | | | | | | |
|---|---|---|---|---|---|---|
| | *consumers buy directly from multiple local producers using a single online platform* | | | | | miles, long-term refrigeration, 'harvesting to order' reduces waste |
| | peer to peer food sharing *individuals share surplus food with others in their locality* | | sb | p2p | 1% | reduced waste [43] |
| **homes** | smart appliances *wireless internet-connected appliances, devices or lighting in the home which allow control or access through apps, voice, or by remote* | inefficient and passive energy use, waste of surplus goods and services | own | b2c | 1-6% | manage energy demand and reduce waste [44, 45]. |
| | prefab retrofits *all-in-one whole-home retrofit* | | own | b2c | 0% | improve home energy efficiency [46] |
| | peer to peer exchange of goods *individuals or households exchanging products or other material goods through an online marketplace* | | sb/own | p2p | - | reducing the demand for new goods [47] |
| **energy** | energy service company *offer households a long-term contract with a third-party service provider (the energy service company) which guarantees to ensure their homes are warm, comfortable, well lit* | inefficient and passive energy use | sb | b2c | <.1% | Improve energy efficiency [48] |
| | electric vehicle to grid *electric vehicle owners share excess battery capacity with the grid operator* | | sb/own | b2c | <.5% | reduce energy losses by reducing transmission distances between electricity generation and consumption [35] |
| | peer to peer electricity trading *households who generate their own electricity the opportunity to trade with other households* | | sb/own | b2c/p2p | 0% | |

Table 1 summarises the low carbon innovations which are the focus of this study. In earlier research we identified over 35 different low carbon innovations that could all potentially disrupt consumer markets and lower consumer based $CO_2$ emissions if they are adopted at scale [5, 22]. In this study we select 12 of these innovations. These are all consumer facing and on the fringes of market share. They represent four main consumer sectors which all require significant reductions in $CO_2$ emissions. These are mobility, food, homes and energy. Products and services within the sharing and service based economy offer potential sources of novelty to consumers through alternative models of provision [37, 49]. The 12 innovations also represent these alternative retail models of provision. This includes business to consumer (b2c) and peer to peer (p2p). Table 1 summarises the range of innovations across these key selection criteria. It shows that innovations range across sector (column (a)), the incumbent provider (column (b)) type of provision (column (c)), retail model (column (d)), market share

(column (e)), and potential for GHG emissions reduction (column (f)). In mobility the dominant consumer behaviour is private car use which accounts for over 75% of UK private vehicle kms [50]. We consider three novel alternatives with the potential to reduce emissions: car clubs, shared taxi and mobility as a service (MaaS). In the food sector the dominant consumer behaviour is food shopping from large scale food retailers which accounts for 95% of grocery expenditure [51]. We consider three alternatives which have the potential to reduce food miles and food waste: rooftop urban farming, digital hubs for local food and peer to peer food sharing (p2p food). In the homes sector and energy sector the dominant consumer behaviour is inefficient and passive energy use and waste. We consider three home innovations that manage energy demand, improve home energy efficiency and reduce demand for new goods: smart appliances, prefab retrofits and peer to peer exchange of goods (p2p goods). Finally in the energy sector we consider three energy innovations that have the potential to improve home energy efficiency and reduce losses by reducing transmission distances between electricity generation and consumption: energy service companies, electric vehicle to grid (electric v2g) and peer to peer electricity trading (p2p electric).

### *2.3 Main contribution of this work*

This works makes a significant contribution to the established empirical work which traditionally has concentrated on single sector, single innovation studies. We take a multiple sector approach to capture the cross sector attributes of consumer facing innovations in mobility, food, homes and energy sectors, measuring their value to potential consumers. We also take a multiple innovation approach within sectors to capture a wider range of attributes. Low carbon innovations across sectors are characteristically very diverse in their consumer offering. We also extend the application of an established framework beyond mobility into three other consumer sectors.

## 3.0 Method

### *3.1 Repertory grid technique*

Repertory grid technique (RGT) has been widely employed in consumer research over the last 30 years [52-54]. There are many examples of empirical research based on RGT. Sühlsen and Hisschemöller [53] examine the influence of renewable energy companies, van de Kerkhof, Cuppen [54] evaluate stakeholders' conceptions of the long term vision for hydrogen, and Eden and Jones [52] analyse how consumers categorise different types of vehicles.

Repertory grid includes two main components, 'elements' and 'constructs'. Elements are objects that people have some familiarity with, in our case low carbon innovations. Constructs are distinctions people make between elements as they relate these elements to their own world. The first step in RGT is the structured interview. Participants randomly select a triad of elements (presented on cards) and are then asked to specify the way in which two are similar and different from a third, this is repeated several times until a saturation point is reached. In a second phase participants then select the constructs they consider are most important for the topic and rank all the elements against these on a scale. The latter

stage enables statistical analysis which visualises the distances between the elements as perceived by the participants [53]. Elements which cluster share common constructs and interpretation is by drawing on qualitative interview findings.

RGT is chosen here because it helps participants to develop constructs around less familiar elements as is the case with low carbon innovations which have yet to make a significant impact on the market. It combines a qualitative phase which provides rich, explanatory and contextual data with a quantitative phase which facilitates more descriptive and generalizable findings. The method also requires only a limited number of interviews to identify the full range of constructs (saturation normally reached between 15 and 25 interviews) [53, 55].

*3.2 Selection of participants*

67 participants were recruited by a local agency in Norwich, UK. All participants lived in or around the city. All participants owned a smart phone, were familiar with using smart phone technology (including apps) and were interested in new technology. Equal numbers of men and woman and age groups 18 to 65 were included.

Norwich was chosen as a representative city in England and Wales. It is comparative with the national average in terms of population composition (see Appendix C).

*3.3 RepGrid interviews*

Interviews were held during three separate workshops in Norwich, UK during the period March to May 2018. Each interview took approximately 45 minutes. Participants were given an introduction to all 12 low carbon innovations (shown in Table 1) through a short presentation. Then the RGT was applied. The low carbon innovations were presented on cards. Participants picked three cards at random and the question asked "how are two innovations similar and different from the third in the way they appeal to people in general". We emphasised the generality to avoid participants expressing only their own views and preferences. When no new constructs emerged, participants were invited to choose three new cards and repeat the exercise. After 30 minutes (or saturation) participants were asked to select the three constructs they considered to be "most important in terms of how they appealed to people in general". They then ranked all 12 innovations with respect to these on a 7 point scale. To reduce interviewer bias we developed and piloted an interviewer protocol to guide participants through the elicitation and scorings (see Appendix B). All interviews were recorded with the participant's permission. Respondents were rewarded for participation with £35 in shopping vouchers.

4.0 Analysis

For the qualitative analysis we used a three level process as described by Wolcott [56] consisting of a descriptive phase in which we examined the verbatim constructs as elicited from participants. The next phase consisted of analysis in which we coded constructs according to overarching themes. Finally interpretation was relative to the quantitative analysis. For the quantitative analysis we used descriptive statistics comparing mean scores against main attributes.

## 5.0 Qualitative Results

Participants mentioned 471 different constructs. This 'raw data' was coded according to 34 different categories (see Table 2). Categories were formed based on two criteria using the 2x2 analytical framework. The first criteria (private versus public domain) distinguished between constructs that directly benefitted the private individual compared to those that benefitted the environment, society, local communities or other people. The second criteria was the functional versus symbolic domain. For the functional domain this included constructs related to use, access, control, choice, flexibility, familiarity, compatibility, time saving, efficiency, quality. For the symbolic domain this included constructs related to appearance, image, identity, autonomy, novelty, change, and signalling. It is worth noting here that we draw a wider inference from Sovacool and Axsen [21] to more specifically distinguish public functional attributes from public symbolic. For the former this includes the extent to which innovations appeal because they are familiar or compatible with existing norms of behaviour. For the latter this includes the extent to which they appeal because they challenge incumbent models of retailing or require significant change. Categories were then grouped hierarchically to form 11 main attributes. Accuracy and validity of this coding was tested by 3 separate coders. Inter-coder reliability was 89%.

Table 2 – Construct categories and attributes

| attribute | attribute name | construct category | construct side 1 (positive appeal) | coding criteria | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | private | public | functional | symbolic | mentions (n) |
| A1 | saves money, saves time or improves health | C1 | offers clear monetary benefits | x | | x | | 72 |
| | | C5 | is more time efficient | x | | x | | 22 |
| | | C22 | positively supports healthy living | x | | x | | 7 |
| | | C28 | clearly benefits the individual | x | | x | | 3 |
| A2 | ease and flexibility of use | C4 | is easy to use, reduces hassle or is more convenient | x | | x | | 27 |
| | | C9 | enables or improves controllability | x | | x | | 15 |
| | | C18 | allows users to choose alternative forms of good | x | | x | | 10 |
| | | C24 | offers visible, tangible or otherwise salient benefits | x | | x | | 6 |
| A3 | ease and flexibility of access | C6 | is widely accessible | x | | x | | 18 |
| | | C17 | requires no prior knowledge | x | | x | | 11 |
| | | C19 | improves accessibility through use of smartphone | x | | x | | 9 |
| | | C10 | is always available when you need it (or available on demand) | x | | x | | 14 |
| A4 | trusted, tried, tested | C3 | is trusted, reliable and good quality | x | | x | | 50 |
| | | C12 | is tested or trialable | x | | x | | 12 |
| A5 | identity signal | C11 | enhances personal image and self-identity | x | | | x | 13 |
| | | C29 | has a pleasing appearance | x | | | x | 3 |
| A6 | environmental benefits | C2 | reduces impact on the environment | | x | x | | 57 |
| | | C15 | maximises use of resources | | x | x | | 11 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| A7 | social benefits | C7 | directly benefits local economy or community | | x | x | | 16 |
| | | C23 | benefits a collective, wider population | | x | x | | 6 |
| A8 | social stability | C8 | fits easily into current ways of doing things | | x | x | | 16 |
| | | C21 | hands over responsibility to others | | x | x | | 7 |
| | | C30 | positively supports collective safety | | x | x | | 3 |
| A9 | inter-dependencies | C14 | encourages mutual interactions or builds friendships | | x | x | | 11 |
| | | C20 | involves or strengthens interactions within a community | | x | x | | 8 |
| | | C25 | connects people with producers | | x | x | | 5 |
| | | C27 | actively builds relationships with other users | | x | x | | 5 |
| | | C32 | involves users in creating or providing good or service | | x | x | | 2 |
| A10 | novelty | C13 | offers change through new, exciting technological opportunities | | x | | x | 11 |
| | | C31 | fits a required future or destiny | | x | | x | 2 |
| | | C33 | reduces the need for owning a good | | x | | x | 2 |
| | | C34 | different from current ways of doing things | | x | | x | 1 |
| A11 | independence from others | C16 | reduces dependence on others | | x | | x | 11 |
| | | C26 | enhances separation from others | | x | | x | 5 |
| | | 34 | | 16 | 18 | 26 | 8 | 471 |

Table 2 shows the distribution of construct categories (numbered C1 to C34). The most frequently mentioned overall was C1 ‘clear monetary benefits’ (n=72) followed by C2 ‘reduces impact on the environment’ (n=57). The ordering from A1 to A11 reflects the grouping of categories to form 11 distinctive attributes (Table 1 columns 1 and 2). Within each attribute constructs are organised according to their frequency.

Attributes bring together related construct categories which can then be mapped onto the 2 x 2 matrix reflecting their position relative to the four domains of attributes: private functional, private symbolic, public functional, and public symbolic. Attributes are summarised below.

A1 **saves money, saves time or improves health (C1, C5, C22, C28) (n=104) – private functional domain**: This relates to using innovations which benefit the individual in terms of better use of money, time and health. These are all core, private benefits relating to essential, hygiene factors, including the need for personal wealth, health and leisure [57]. Amongst these personal benefits, the financial savings clearly dominate and are most frequently highlighted by participants. More participants emphasised the general appeal of knowing how much money they could save from purchasing and using [n=72] (“people can see how much money they save” [SB6], “they can get things cheaper, a bargain” [SB7], “inexpensive to run” [EC3]). Short term money savings were more salient than long term although longer term investment opportunity was an additional framing within monetary benefits that appealed (“can make money out of it” [EC9], “sure about a return on investment”

[HP7]). Personal time savings or efficiencies included better use of time, less wasted time, not requiring additional time. In terms of health, personal mental and physical benefits were highlighted through very specific constructs which related to use being ("not stressful" [CW4], "it doesn't mean additional stress" [HP10]).

A2 **ease and flexibility of use (C4, C9, C18, C24) (n=58) - private functional domain**: Personal gains from using innovations. These specifically relate to improvements in everyday life ("makes everyday activities very simple" [MW14], making life easier ("reduces effort" [HP6]), extending choice ("a range of choice of products" [EC9]), and offering more personalised choice ("can be tailor made to meet specific needs" [HP5]). Other private gains related to variety of use ("has versatile and diverse applications" [CW8]), convenience (easy to use and less hassle), giving people more personal control, and freeing them from the burden of labour.

A3 **ease and flexibility of access (C6, C17, C19, C10) (n=52) – private functional domain**: Distinct from 'A1' it relates more specifically to personal expertise (knowledge), personal circumstances (income and ownership), and physical ability. Many participants talked positively about innovations that extended current services to more vulnerable people, ("helps less mobile people to travel" [MW13], "provides a service for people less physically able to carry out normal life" [HP5]). This more public outcome situates this attribute closer to public functional in the framing (Figure 2). Participants also talked positively about innovations that did not require prior or specialist knowledge, time to research and were affordable. Improved accessibility, one stop shopping and reduced effort through smart phone technology was also seen as appealing.

A4 **trusted, tried, tested (C3, C12) (n=62) - private functional domain**: Personal gains from using an innovation of known quality and performance. Trust was a very salient issue (n=50). Participants generally associated this with confidence in the quality. Some attached this to wider stakeholders involved in the supply and delivery of the innovation ("they are provided by professionals you can trust [MW1], "does not involve people you don't know coming to your door" [HP4]). Trust also related to the motivations behind provision ("you can trust the motive behind it" [HP3]). Related also were reliability of guarantees and assurances of quality ("there is not the possibility of hidden restrictions to the service" [SB10], "there are standards to follow" [EC8]). Known quality and performance also related to observability in terms of being known about or seen to be working ("they are tested services" [SB2], "people known about them already" [HP12]).

A5 **identity signal (C11, C29) (n=13) – private symbolic domain**: Providing or enhancing desirable aspects of user's individual or social identity and how this is communicated and protected. This includes self-consistency (doing the right thing), promoting intentional lifestyle choices and altruism (helping people to help others). Participants mentioned a desire to do the right thing and the appeal of products and services that were consistent with this ("promotes an environmentally friendly

lifestyle" [EC5], "they stop you doing something which is morally wrong" [SB13], "does not conflict with personal image" [LK6]). The general aesthetics of the home (and what this communicates to others) was also mentioned ("not potentially detrimental to the appearance of the home" LK11], "they are not large and unsightly on a house" [SB6], "they don't look unattractive" [SB8]).

A6 **environmental benefits (C2, C15) (n=68) – public functional domain**: Benefits ranging from reduced impact on the environment, reduced waste, reduced $CO_2$ emissions and improved energy and fuel efficiency to more efficient utilisation of resources (stuff and space). Participants (n=17) identified constructs related to the broad environmental benefits of low carbon innovations, ("better for the environment" [MW5])". Participants (n=17) also spoke about waste reduction in more specific terms, "reducing", "avoiding", "preventing" waste. Saving greenhouse gas emissions, lowering the carbon footprint, reducing pollution were also salient. A few participants identified better utilisation of assets including urban space and the trade between agricultural space and use for other services such as solar farms.

A7 **social benefits (C7, C23) (n=22) – public functional domain**: Distinctive from environmental benefits this is the extent to which the innovation results in direct benefits to society including local economy or local community (and this motivates the individual). Many participants talked about direct benefits to the local community and economy (N=12) ("keeping things local" [HP9], "using local resources" [MW5], "supporting local businesses" [SB5] "creating local jobs" [MW14]. Others talked about establishing and protecting community, ("builds community spirit" [CW3], "brings the community together" [LK8]).

A8 **social stability (C8, C21, C30) (n=26) – public functional domain**: Purchase or use of an innovation protects or enhances current ways of doing things. This also reduces the need to change things people are used to doing on a day to day basis and protects social norms. This incorporates concerns participants mentioned with regards to compatibility and familiarity of innovations ("does not challenge current norms" [CW1] "not a new fad, already entrenched in community life" [HP12] , "not too new and complex and people can understand it" [HP12], "deals with something people understand" [SB1]).

A9 **inter-dependencies (C14, C20, C25, C27, C32) (n=31) – public functional domain**: Purchase or use of an innovation establishes or strengthens interactions with others' and builds social networks and relationships. This includes providers and/or other users. Many participants identified the benefits of connecting with producers, other users, and encouraging mutual relationships and even friendships to develop, ("brings provider and consumer together for mutual benefit" [HP11], "brings a service closer to the consumer" [HP7]. Some participants spoke about the appeal of sharing ("you can give something to a person that they want" [SB13], "mutual exchange where both parties benefit" [CW4]).

A10 **novelty (C13, C31, C33, C34) (n=16) – public symbolic domain**: Change through new, exciting and novel technology (features). Opposite to social stability (A8) novelty and change relative to social norms is appealing, ("you can use new gadgets" [MW8], "new and exciting innovations" [MW1], "uses interesting technology" [HP6], "offers a chance to try new things" [LK4]). Some participants saw novelty in not having to own a good or service or having a duty of care which could be burdensome. Some talked about returning to better ways of doing things ("back to living off the land" [HP9], "fit with the future that is required" [EC3]).

A11 **independence from others (C16, C26) (n=16) – public symbolic domain**: Use or purchase of an innovation leads to independence or separation from others, including reducing dependence on other service providers or infrastructure, large organisations or third parties. This incorporates freedom from other agencies ("don't need to rely on others" [LK14]), large organisations, "not dealing with a large company" [HP1], "avoid dealing with business monopolies" [EC6]) and increasing agency ("they bring the power back from companies to the individual" [HP10]). This independence also relates to personal space ("you don't have to share the space with others" [SB13]) or freedom to make more personalised decisions ("you can make personal proactive decisions" [MW7]).

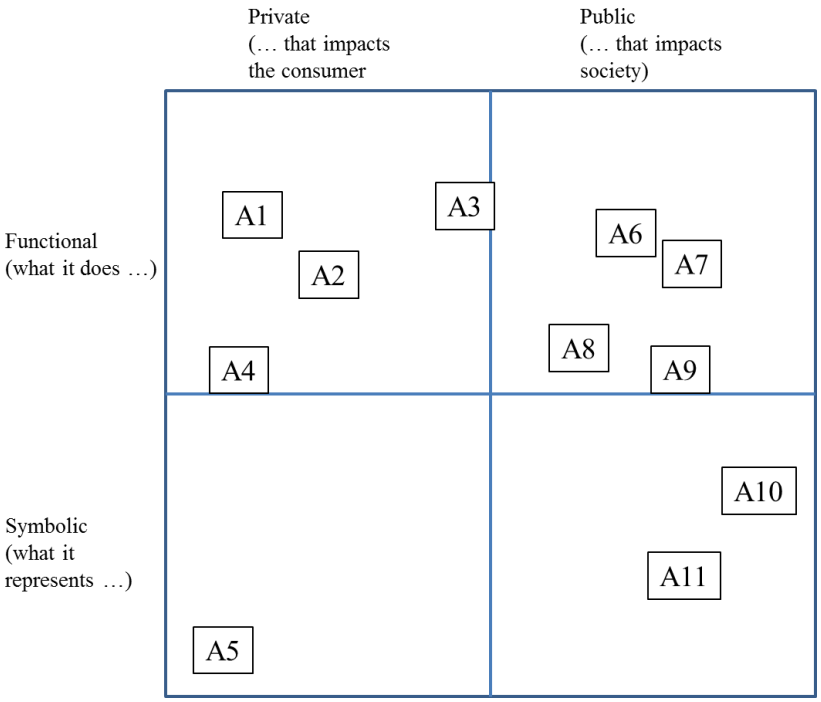



Figure 2 – positioning of attributes within conceptual framework of 4 attribute domains

Figure 2 summarises attributes as they fit within the conceptual framework. Positioning is a qualitative, subjective assessment based on richer qualitative insights provided by the verbatim constructs included in each attribute. Attributes A1 to A4 are all private functional attributes. They relate to core features or functionality which directly impact consumers. Similar to findings in Axsen and Kurani [12], they include money saving (A1) and reliability

(A4). They also include attributes related to ease of use (A2) and access (A3), widely regarded by Rogers [8] and Davis [7] as important determinants of diffusion. A3 also incorporates constructs related to widening social participation hence it bridges between private and public domains.

Attributes A6 to A9 are public functional attributes. In contrast they relate to features or functionality that impact society as a whole. In addition to environmental stewardship, identified in Axsen and Kurani [12], they include attributes related to wider benefits to society (A7), compatibility with societal norms (A8) and interdependencies (A9).

Private symbolic attributes are consistent with Axsen and Kurani [12] and Sovacool and Axsen [21]. They relate to personal image and self-identity (A5). Public symbolic attributes relate to novelty (A10) and independence from others (A11). Trusted, tried, tested (A4) includes constructs related to protecting personal identity (a concern related to the p2p business model) hence it bridges the private functional and symbolic. Interdependencies (A9) relate to the creation of interdependent and mutually beneficial networks that emerge from the p2p business model. Whilst this has public functional benefit, these networks challenge large scale retailers that rely on the b2c model. It therefore bridges between the public functional and symbolic domains.

## 6.0 Quantitative Results

### *6.1 Important attributes of low carbon innovations*

Within the second phase of the RepGrid interview participants were asked to identity three constructs from all those that they had personally mentioned which they felt were ‘most important’ in terms of their appeal to people in general. Participants identified a total of 187 different constructs across all four domains. Figure 3 shows the frequency constructs within specific attributes were identified as important. Private functional attributes (coloured dark purple in Figure 3) are perceived as more important than public functional attributes (coloured dark orange in Figure 3). This fits within theoretical expectations. People prioritise ‘self-serving’ benefits as opposed to those which meet a wider societal need [23]. Money is also a very salient issue [58, 59].

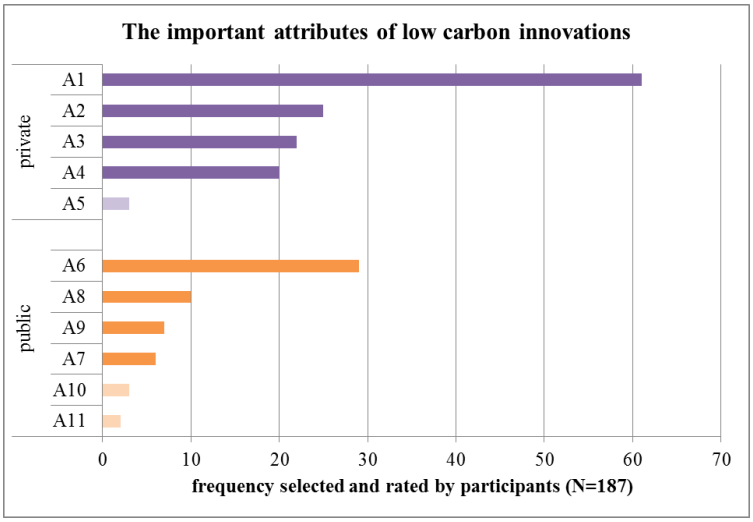


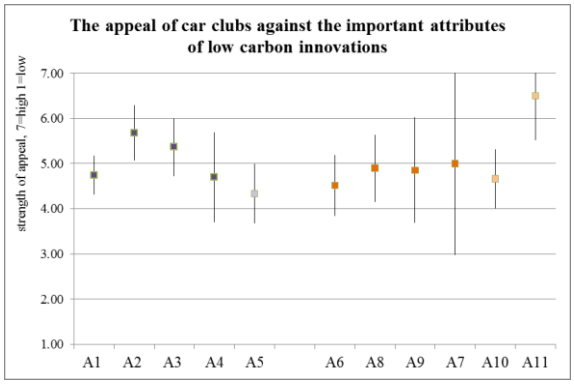
Figure 3 – the relative importance of private functional, private symbolic, public functional and public symbolic attributes

Functional attributes (dark purple and dark orange in Figure 3) are preferred over symbolic (light purple and light orange in Figure 3) and again this fits with theoretical expectations. Symbolic attributes offer secondary, perceived benefits and are less frequently mentioned by consumers [15, 16, 26].

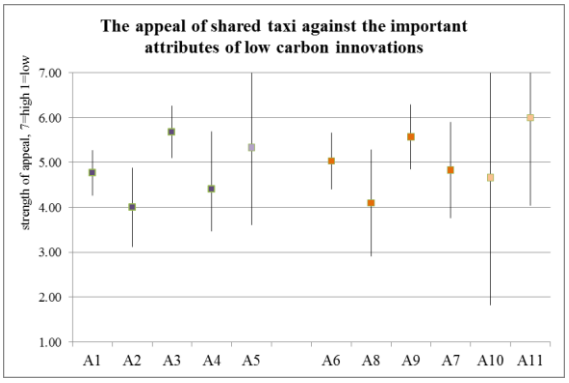
*6.2 The appeal of low carbon innovations*

In the second phase of RepGrid exercise 2, participants were asked to rate all 12 low carbon innovations against the 3 constructs they perceived as most important. Ratings are based on a 7 point scale (where 7=high appeal and 1=low appeal). The next section addresses the question "how do low carbon innovations differ in their appeal against valued attributes?" To address this question we calculate mean ratings for each innovation for each attribute. To compare between mean ratings we define threshold values to distinguish high, moderate and low appeal. These values are calculated using the overall distribution of ratings for all innovations across all attributes (N=2,206). Tercile values divide this distribution into three equal parts. Where we refer to high appeal this reflects a mean rating which lies within the upper tercile, mean rating >=6. Where we refer to moderate appeal this reflects a mean rating which lies within the mid tercile, <6>=4. Low appeal reflects a mean rating which lies within the lower tercile, <4. These threshold values are more suited to comparing mean differences between groups with varying samples sizes and bias towards the upper end of the likert scale.

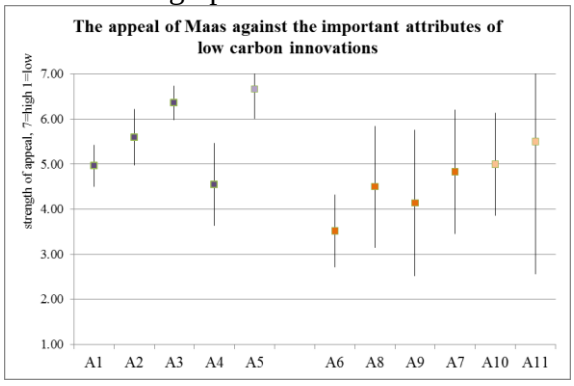
In the next section we present a series of graphs illustrating the appeal of low carbon innovations across the 11 attributes.

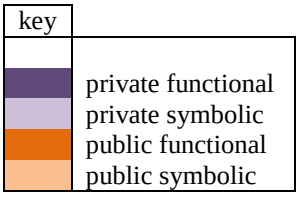



graph 4a – car clubs



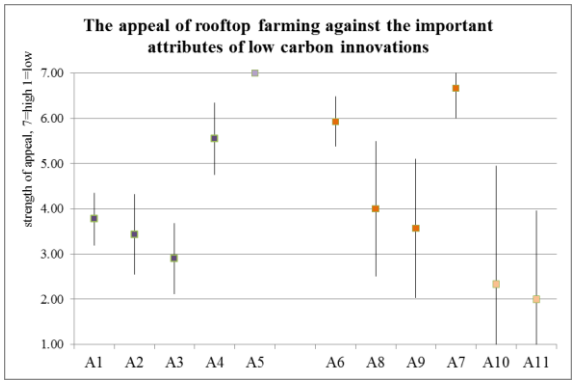

graph 4b – shared taxi



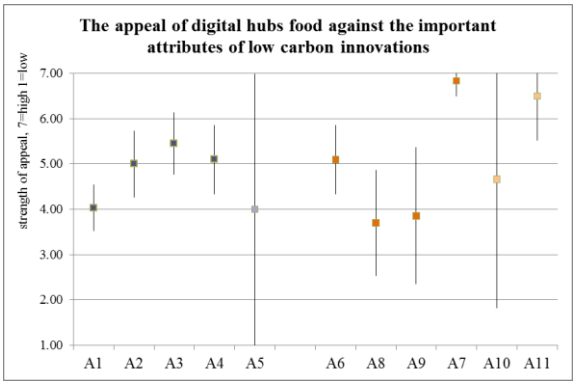



graph 4c - MaaS

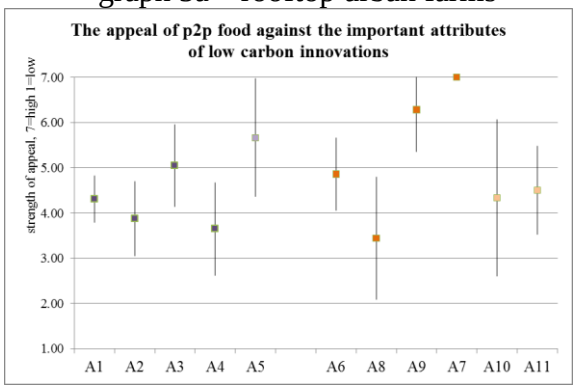
Figure 4 (graphs 4a to 4c) illustrate the appeal of the three mobility innovations across all 11 attributes. In general they show that mobility innovations are more appealing across private attributes, compared to public. Of the three innovations MaaS has the most appeal against private attributes (Figure 4 graph 4c). It is perceived as the easiest and most flexible to access (A3). One of the most important constructs within A3 is improved access through the use of smartphones, a key feature of MaaS.




graph 5a – rooftop urban farms




graph 5b – digital food hubs




graph 5c – p2p food

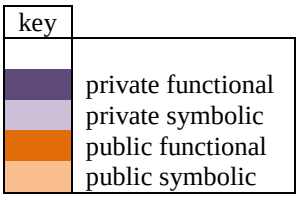
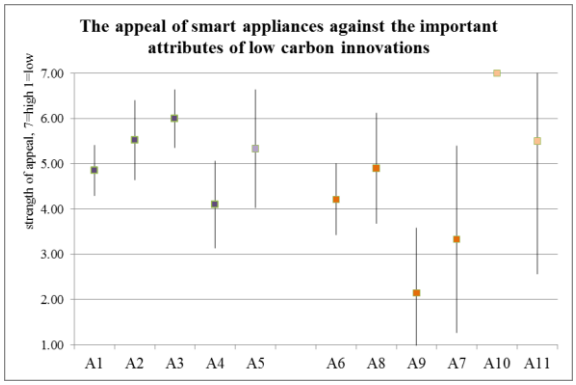
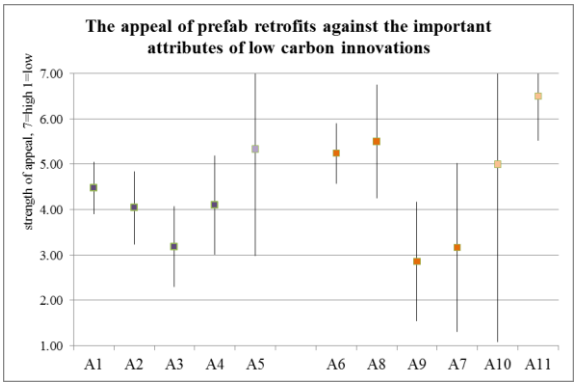


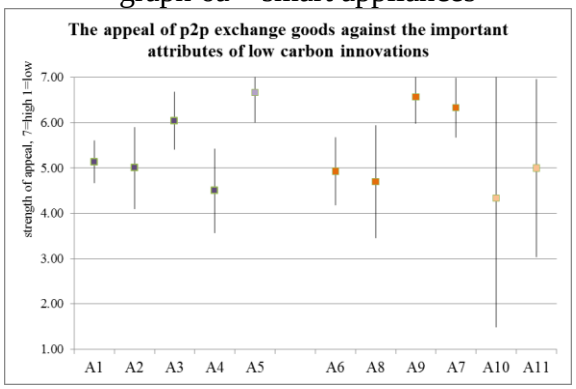

Figure 5 (graphs 5a to 5c) illustrate the appeal of the three food innovations. Food innovations in contrast have more appeal against public attributes compared to private. All three food innovations are highly appealing in social benefits (A7) (Figure 5 graphs 5a to 5c). Although rooftop farming is a novel concept our findings suggest its association with the supermarket model of provision means it is also perceived as familiar (A8) (Figure 5 graph 5a). Innovations that rely on the b2c model (rooftop farming and digital hubs for local food) are more trusted (A4) compared to the p2p model (p2p food sharing) (Figure 5 graphs 5a to 5c).




graph 6a – smart appliances




graph 6b – prefab retrofits




graph 6c – p2p exchange goods

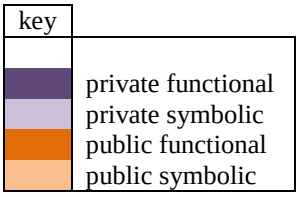
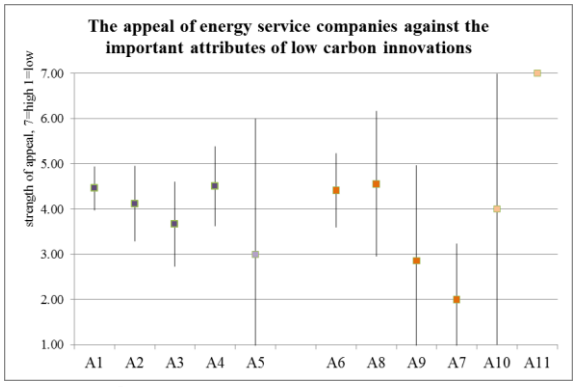
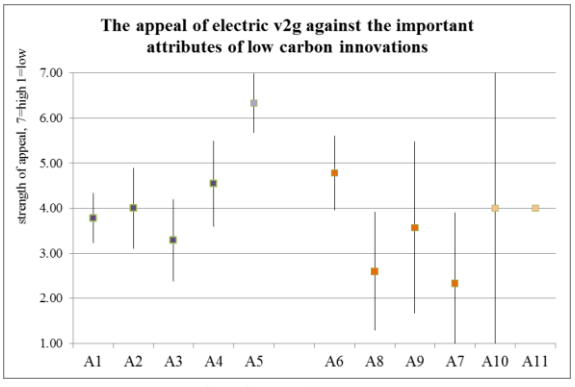


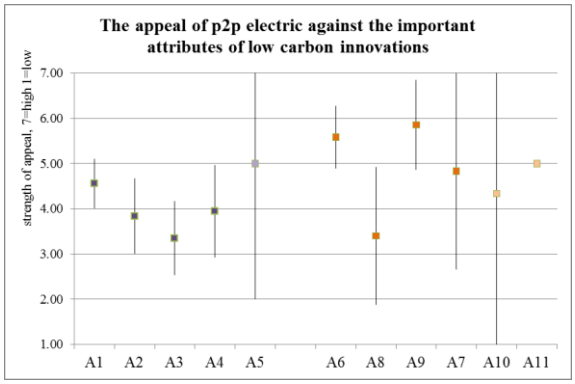

Figure 6 (graphs 6a to 6c) illustrate the appeal of the three homes innovations. In general they appeal across both private and public attributes. Smart appliances in particular are highly appealing in terms of their novelty (A10) yet they also have modest appeal against social stability (A7) (Figure 6 graph 6a). Household appliances and home lighting are routinely used, daily appliances and devices which are very familiar.




graph 7a – energy service companies




graph 7b – electric v2g




graph 7c – p2p electric

Figure 7 (graphs 7a to 7c) illustrate the appeal of the three energy innovations. These three innovations share many similarities in term of their appeal across the 11 attributes. All have low to moderate appeal against private functional attributes (A1 to A4) (Figure 7 graphs 7a to 7c). In terms of trusted, tried and tested (A4) energy service companies and electric v2g have more appeal relative to p2p electric which relies on peer to peer mechanisms (Figure 7 graphs 7a to 7c).

We find private functional attributes are perceived to be more important than public functional attributes. We also find that functional attributes are more important than symbolic attributes (see Figure 3). This is in line with other empirical work that shows private functional attributes are perceived by consumers to be a core and essential component of all products and services [60, 61]. Furthermore many studies show that although symbolic attributes provide consumers with potential sources of added value, this is moderated by their appeal against functional attributes [18, 60]. Typically empirical research shows that low carbon innovations perform less well against private functional attributes when compared directly to incumbent technologies [10]. An important finding in our study is that low carbon innovations variously appeal against the private functional attributes.

*6.3 Potential sources of added value compared to incumbent technologies*

In this last section we consider the research question "what are the potential sources of added value for low carbon innovations within key sectors?" Added value occurs when a product or service provides customers with a unique feature which results in a greater perception of value [15, 16, 62].

Table 3 – The appeal of low carbon innovations relative to high carbon alternatives

| | Appeal against main attributes (high, moderate, low) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Private functional | | | | Private symbolic | Public functional | | | | Public symbolic | |
| | A1 | A2 | A3 | A4 | A5 | A6 | A8 | A9 | A7 | A10 | A11 |
| **mobility** | | | | | | | | | | | |
| *private vehicle use* | *high* | *high* | *high* | *high* | *high* | *low* | *high* | *low* | *low* | *mod* | *low* |
| car clubs | mod | mod | mod | mod | mod | mod | mod | mod | mod | mod | high |
| shared taxis | mod | mod | mod | mod | mod | mod | mod | mod | mod | mod | high |
| MaaS | mod | mod | high | mod | high | low | mod | mod | mod | mod | high |
| **food** | | | | | | | | | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *major food retailers* | *high* | *high* | *high* | *high* | *mod* | *low* | *high* | *mod* | *mod* | *low* | *low* |
| rooftop farm | low | low | low | mod | high | mod | mod | low | high | low | low |
| digital hubs food | mod | mod | mod | mod | mod | mod | low | low | high | mod | high |
| p2p food sharing | mod | low | mod | low | mod | mod | low | high | high | mod | mod |
| **homes** | | | | | | | | | | | |
| *passive and inefficient use of energy* | *low* | *high* | *high* | *mod* | *low* | *low* | *high* | *low* | *low* | *low* | *low* |
| *smart appliances* | mod | mod | high | mod | mod | mod | mod | low | low | high | mod |
| *prefab retrofits* | mod | mod | low | mod | mod | mod | mod | low | low | mod | high |
| *p2p exchange goods* | mod | mod | high | mod | high | mod | mod | high | high | mod | mod |
| **energy** | | | | | | | | | | | |
| *low energy management, high waste* | low | high | high | mod | low | low | high | low | low | low | low |
| *energy service co* | mod | mod | low | mod | low | mod | mod | low | low | mod | high |
| *electric v2g* | low | mod | low | mod | high | mod | low | low | low | mod | mod |
| *p2p electric* | mod | low | low | low | mod | mod | low | mod | mod | mod | mod |

Note: added value above the incumbent highlighted (pink cells).

| key | |
|---|---|
| A1 | saves money, time, improves health |
| A2 | ease and flexibility of use |
| A3 | ease and flexibility of access |
| A4 | trusted, tried, tested |
| A5 | identity signal |
| A6 | environmental benefits |
| A8 | social stability |
| A9 | inter-dependencies |
| A7 | social benefits |
| A10 | novelty |
| A11 | independence from others |
| | incumbent has high appeal |
| | incumbent has moderate appeal |
| | incumbent has low appeal |
| | innovations offer added value above incumbent |

Table 2 illustrates potential added value from all low carbon innovations across all 4 sectors. It shows the appeal of low carbon innovations relative to high carbon incumbents. Ratings for incumbents are drawn from findings in the literature. In the mobility sector empirical research suggests consumers perceive private vehicles as highly appealing against costs (per journey), convenience, control, familiarity, quality and symbolism [20, 63]. We interpret this as high appeal against attributes A1 (money), A2 (ease of use), A3 (ease of access), A4 (trusted, tried, tested), A5 (identity signal) and A8 (social stability). In the food sector supermarkets are highly appealing in terms of low cost (A1), convenience and access (A2, A3), quality (A4), and familiarity (A8) [64]. In homes, utility supplied electricity and gas is available on demand through centralised infrastructures or provision. The relatively low cost and salience of energy within household expenditure [65], combined with the deeply embedded,

routinized nature of energy using activities in the home, mean that households do not generally actively manage their energy consumption [66]. We interpret this as high appeal against attributes ease of use (A2), ease of access (A3) and familiarity (A8) .

Our main finding is that low carbon innovations offer added value within the public domain but are on the whole uncompetitive within the private domain. Apart from MaaS all innovations are perceived by potential consumers to benefit the environment. This is a fundamental and core feature of low carbon innovations. Insights from our qualitative research, however, suggest this added value is more nuanced. It includes lowering $CO_2$ emissions, saving energy, reducing waste, and using space more efficiently.

Across mobility, food, homes and energy sectors there is evidence of added value beyond this core environmental benefit. Food innovations are highly appealing in terms of their direct benefits to society and local communities. Food provision in this context is highly valued when it is local, supports local businesses, protects and builds communities around food and builds community spirit. In the homes sector p2p exchange of goods also offers added value here. In this context exchanging goods in a localised environment is perceived as strengthening local communities.

Homes and energy innovations are moderately appealing in terms of their novelty. Within the homes sector smart appliances are highly appealing. In this context novelty relates to enabling the user to access new and exciting technology, using new gadgets or trying new things. Innovations based on the sharing economy also offer added value related to building social networks. In this context interdependencies occur as people exchange goods and services, connecting them with producers and other users. This also encourages mutual relationships and friendships.

## 7.0 Discussion

Low carbon innovations have the potential to significantly reduce consumer based $CO_2$ emissions if they are adopted at scale and if they significantly displace high emitting incumbent behaviours. There are many low carbon innovations currently within the marketplace across major consumer sectors including mobility, food, homes and energy but none have moved beyond the early adopter stage of diffusion described by Rogers [8].

In his hierarchy of attributes Levitt [16] distinguishes clearly between primary, secondary and tertiary attributes. Primary attributes are core benefits, they form part of the consumers' 'mimimum purchase requirements' [16:84]. These are features expected by the mass market such as low cost, ease of use, ease of access, and familiarity. Consistent with the substantive literature we find low carbon innovations are unattractive against these primary attributes when compared directly to large scale incumbents whose business models are built on volume, scale and costs. The way a company manages its marketing can become the most powerful form of differentiation [16]. It is important that low carbon innovations are positioned within the marketplace to emphasise sources of added value above incumbents. Our study shows they appeal against a range of public attributes. Within this domain there are potential niche markets, segments of consumers who value local provision, the sharing

economy, improved environment, lower pollution, better use of local resources, and wider benefits to society. In their study into mobility Sovacool and Axsen [21] for example frame a distinctive group who value more what cars do for society compared to the individual benefits. These are environmentalists or climate activists, people who more activitely take on the role of environmental stewardship. In the food sector, Albrecht and Smithers [67] identity a distinctive group of consumers who value healthy, environmentally friendly and nutritious food.

Consumers often need encouragement to look beyond price, they need help in understanding other sources of added value [68]. Pro-active campaigns are required by government, local authorities, and industry which match the unique sources of added value low carbon innovations offer, to the characteristics and social identities of consumers. In the food sector for example, consumers signal their membership in a culture or food group by asserting the specificity of what they eat and how it is prepared. Low meat diets for example align individuals with social and political issues such as treatment of animals and protection of the environment [69]. Meal box schemes provide socially acceptable solutions to the lifestyle demands of many families because it retains the culturally approved notion of 'cooking from scratch' [70]. In the mobility sector car clubs now focus on branding activities which position them as a more 'hip' and economically viable consumption model for consumers 'in the know' [71]. These active strategies seek novel differentiation from incumbent technologies by targeting specific social groups rather than trying to compete directly against core primary attributes.

Disruptive innovation is a field of business and management scholarship interested in the transformative potential of novel goods and services for consumers. Its outcome is the dislodging of incumbent firms and interests from entrenched market positions such as the case with the strong incumbent technologies in mobility, food, homes and energy. It builds on the seminal work of Christensen [72] who theorises that incumbents fail to see disruptive threats from innovations which score well on a wholly new set of attributes. If these disruptive innovations effectively create a new market, a new set of demands and preferences from consumers emerge [22]. Our study clearly shows that low carbon innovations score well on a new set of dimensions compared to high carbon incumbent products and services. To develop this disruptive consumer driven transition, strategies are required by government, industry and marketing practitioners to build and support new value propositions around these attribute domains. As new markets develop innovation will be driven towards improved performance on the new dominant adoption criteria.

In the longer term product development strategies for low carbon innovations need to incorporate mainstream attributes. In the low carbon mobility sector, Elon Musk has created an electric vehicle (the Tesla) which competes on many mainstream attributes against brands such as BMW and Mercedes [73]. Product development and marketing strategies also need to embrace opportunity across sectors where homogenous groups of consumers value the same attributes. We identified a number of cross sector innovations that appealed to consumers against similar attributes. Innovations in mobility and food all appeal against social benefits, emphasising their value to homogenous groups of consumers who share characteristics and a

desire to invest in their community. This could include rural communities, co-workers, and students.

Low carbon digital innovations, those that use web based or app based technologies have a high potential to improve their performance against private functional attributes, highly valued by consumers [23]. For example, 11th hour food apps such as 'Too Good To Go' [74] use technology platforms which are gaining increasing popularity with consumers. In line with technological and social learning app based services have greater potential to increase their performance against attributes such as A2 ease of use (as ordering and payment systems improve and people gain more knowledge and trust in using them), A3 ease of access (as the technology platforms spread), and A5 identity signal (as food trends towards lower waste attract new consumers who want to portray this self- image).

Tornatzky and Klein [17] suggest that perceptions of added value are influenced by other actors involved in provision and implementation. In selecting low carbon innovations we compared between competing models of the economy. We included three different peer to peer low carbon innovations, relating to food, exchange of products and services and electricity. The sharing economy is an alternative to the broadly accepted model of private ownership. It is a relatively new development and emphasises the human need for community and connection with each other [49]. It also fits the rational consumer model where people seek greater value for lower costs, recyling and sharing excess [35]. A recent survey in the UK suggest there has been a 60% increase in participation in the sharing economy (over an 18 month period) [75]. We find that although the benefits of the sharing economy are salient, participants trusted innovations more where they could rely on known providers and retailers. Specific concerns related to privacy, dealing with unknown providers and quality assurance.

In his theory of innovations Rogers [8] sees diffusion as a social process which relies on the strength of social networks and frequency of communication between adopters and potential adopters. The sharing economy has been described as one of the 'most significant economic developments' of the past decade [37, 38]. It provides consumers with alternative consumption models to exclusive ownership [76].

The ubiquity of smartphones and other enabling technologies has aided the growth of the sharing economy, both in terms of scale and scope (breadth of assets being shared), and has facilitated sharing between strangers [36], creating an extensive pool of people with whom to participate in sharing activities [38]. Benkler [77:275] identifies this type of sharing as 'impersonal, social sharing', emphasising the point that sharing activities are no longer confined to those within one's own social network. Sharing platforms have also reduced the transaction costs associated with participating in sharing activities, further contributing to the growth of the sharing economy [78]. Similarly, growing urban populations have also been accredited with facilitating the growth of the sharing economy, due to the high concentrations of under – utilised assets in urban areas [38]. In particular, peer-to-peer, or consumer-to-consumer (c2c) sharing activities have been described as those 'that aim to increase the most widespread participation by equipotential participants' [79:33].

In our study we find low carbon innovations that rely on this mechanism offer added value related to the creation of localised networks, friendships and personal satisfaction from sharing with others. Low carbon innovations within the sharing economy have the potential to become social organisations. They connect homogenous groups of like-minded people that share a collective identity [80].

The ability of sharing economy practices to be scaled at the rates seen over the past decade has been attributed to the fact that the sharing economy harnesses, and in most cases capitalises on, currently under-utilised physical assets [81], (including p2p electricity sharing, p2p exchange of goods, and p2p food sharing, as seen in this study). Further, the diverse range of attributes in the private functional, private symbolic, public functional and public symbolic domains offered by innovations using this business model appeal to different groups of people for different reasons, as demonstrated by this study. Therefore, the diffusion and high visibility of the sharing economy can, in part, be attributed to the range of ways it appeals to people.

Bus and rail commuters are a potential target market for this sharing economy model. MaaS offers additional shared transport modes to replace the private car for the first and last mile of public transit connections [82]. Currently exclusive bike-sharing docks or parking bays are offered for ride sharers in railway stations, as an incentive to consumers. Our research suggests there is also an opportunity for providers of these services to further stimulate the co-creation of mutually beneficial commuting networks, through technology based apps that encourage connectivity between not only like-mindedness but also other lifestyle characteristics that lead to common patterns of commuting.

Customers' perceptions of attributes are dynamic. Any systematic classification of attributes and evaluation of the appeal of low carbon innovations against them must also be dynamic [60]. In this study we find that low carbon innovations offer minimal added value against private functional attributes which are essential for mainstream adoption [16]. There is potential for government and industry to invest in programs that aim to educate and demonstrate the full range of attributes offered by low carbon innovations. These interventions need to challenge perceptions that hinder their diffusion into the mainstream including perceptions that they have limited appeal over and above their low carbon characteristics. These interventions could include consumer trials in high density communities which have strong social network connections. In recent years there is likely to have been a positive shift in the performance of low carbon innovations against some of the core attributes, including cost and ease of use. Further research is required which accurately measures this dynamic change which could lead to more accurate positioning of low carbon innovations with respect to the preferred consumer attributes of incumbent technologies.

## 8.0 Conclusions

In summary, by using repertory grid techniques to elicit consumer perceptions of a range of low carbon innovations in mobility, food, homes and energy sectors, we found that

alternatives to high-emitting mainstream practices appeal for a range of public and symbolic reasons, but that out competing current practices on private functional attributes is a challenge. Our findings also raise important questions for further research such as how experience of using or adapting an innovation shapes perceptions of its functionality and how this is communicated through social networks.

Appendix A – Norwich population characteristics

| | Norwich | National Average (towns and cities in England and Wales) excluding London |
|---|---|---|
| Population<br>Age 16-64<br>Age 65+ | <br>66.65%<br>17.19% | <br>67.1%<br>15.4% |
| Home ownership | 54.23% | 55.4% |
| Proportion 'limited a lot' by health problems | 5.6% | 11% |
| Proportion of full time students | 12.09% | 11.7% |
| Employment<br>Manufacturing<br>Wholesale and retail<br>Professional finance and information<br>Public admin, health and education | <br>7.3%<br>17.6%<br>15.82%<br>28.79% | <br>9.2%<br>16.9%<br>13.4%<br>29.1% |
| Education<br>Proportion of resident population age 16+ with Level 4 qualifications and above | <br>25.48% | <br>24.3% |
| Income deprivation rank | 50 | 1=most deprived, 109= least |

Appendix B – Interview protocol

Preamble

| | |
|---|---|
| Introduce yourself. Thank you again for participating.<br><br>This research is about how people understand different types of innovations.<br>- How do you think these innovations appeal to people in general?<br>- It doesn't matter if you've no experience yourself of using them. We just want to know what you think in general about them.<br>- No right or wrong answers.<br>- OK to record.<br>- Thinking out-loud is important to us (deleted afterwards). | *Record participant ID on recording sheets or notes pages*<br><br>*Reinforce main question on the top of the RepGrid*<br><br>*Start recording.* |

Exercise 1 – RepGrid construct elicitation

| | |
|---|---|
| On each of these cards there is an innovation .<br><br>We are going to use these cards to help explore how you think these innovations appeal to people in general.<br>- We are going to use this sheet to help organise these cards.<br><br>Please choose 3 cards and place them on the board.<br>- Great! So you have selected ____ , ____ and ____ are you happy with what these are?<br><br>From these cards I want you to choose which two you think are the most similar in the way they appeal to people in general, and which one is different from these other two.<br>- Please try and think about how they appeal to people now rather than in the future.<br><br>Great! So you have selected ____ and ____as being similar and ____ as being different in terms of how they appeal to people in general.<br>- Now, can you describe how you think these two are most similar, and this one is different in terms of how they appeal to people in general?<br><br>You have mentioned several things there which I've jotted down. I'd like to go through each in turn.<br>- You mention ___ and ___ are similar because ____, can you say a little bit more about what you mean.<br>- Can you say something about what makes ____ | *Hand the cards to the subject and ask them to shuffle*<br><br>*Make sure subject understands the rules of the game!*<br><br>*Can I ask you to name the innovations as you talk about them so we can record all your thinking.*<br><br>*Take care when eliciting opposites – if new constructs emerge then make a note and follow this up. Try and focus the participant on generating* |

| | |
|---|---|
| different?<br>- Is there anything else you can think of which makes ____ and ____ similar and ____ different?<br>- you mention ___ and ____. To me it sounds like this one(s) ____ is the one you emphasize most. Would you agree? Why don't we focus on this one(s) right now and we can come back to the other ones afterwards"<br><br>"So just to make sure I understand, do you think that these two innovations have similar appeal to people in general because X and this one is different because it is not X"?<br><br>OK, great. Now we're going to do the same again with a different set of three innovations. | *the opposite before moving on.*<br><br>*Write the agreed construct and it's opposite on the appropriate post it notes. On the relevant post it notes write which innovations generated the construct.*<br><br>*Participant draws new set cards.* |

Exercise 2 – Full RepGrid Scoring

| | |
|---|---|
| Before we start the next exercise let's just quickly review all the ways that you think these innovations appeal.<br><br>In this next exercise we are going to work with just three.<br>- The three you think have the most appeal to people in general.<br>- can you identify these three.<br>- Now let's remove all the others from the board.<br><br>Excellent, now we will move on to the next stage.<br>- On the game board you will see a grid from left to right. On the left side is 'appeals because' and on the right side 'does not appeal because'.<br>- Let's take this first reason why you think these innovations appeal to other people in general and place it on the top left side on the grid and on the opposite side (right side) let's place the opposite.<br><br>Can I ask you, one by one to position all the innovations on the grid according to how much you think they appeal because "name | *Read through the concepts identified and their opposite.*<br><br>*Guide the participant into placing three concepts from the 'appeals because' side of the board in the middle of the board along with the opposite 'does not appeal because'.*<br><br>*Place the first construct on the appropriate position on the board, and remove the other two (remove opposites also).* |

| | |
|---|---|
| provided construct" or how much you do not think they appeal because "name provided construct on right hand side of grid".<br>- '7' = appeal and '1' = does not appeal.<br>- Please feel free to think out-loud as you decide where they all fit.<br><br>We are now going to repeat this with the 2nd reason.<br><br>We are now going to repeat this with the 3rd reason.<br><br>Well done and thank you very much | *Remind participant to identify the name of the innovation and the positioning on the grid.*<br><br>*Take a photograph.Make sure you take it from above the board so constructs can be clearly seen* |

Appendix C – Interview summary

| ID | gender | age | | ID | gender | age |
|---|---|---|---|---|---|---|
| CW2 | F | 35-44 | | LK4 | M | 35-44 |
| CW3 | M | 65+ | | LK5 | F | 25-34 |
| CW4 | F | 25-34 | | LK6 | M | 45-54 |
| CW5 | M | 45-54 | | LK8 | F | 45-54 |
| CW6 | F | 55-64 | | LK10 | M | 25-34 |
| CW7 | M | 25-34 | | LK11 | F | 45-54 |
| CW8 | M | 65+ | | LK12 | F | 18-24 |
| CW9 | F | 18-24 | | LK13 | F | 18-24 |
| EC1 | M | 35-44 | | LK14 | F | 25-34 |
| EC2 | M | 35-44 | | MW1 | F | 25-34 |
| EC3 | M | 35-44 | | MW2 | F | 35-44 |
| EC4 | M | 45-54 | | MW4 | M | 45-54 |
| EC5 | M | 35-44 | | MW5 | M | 55-64 |
| EC6 | M | 25-34 | | MW6 | F | 25-34 |
| EC7 | F | 55-64 | | MW7 | F | 18-24 |
| EC8 | F | 25-34 | | MW8 | F | 45-54 |
| EC9 | F | 45-54 | | MW9 | F | 55-64 |
| EC11 | F | 45-54 | | MW10 | F | 35-44 |
| EC12 | M | 55-64 | | MW12 | F | 18-24 |
| EC13 | M | 45-54 | | MW13 | F | 35-44 |
| EC14 | F | 35-44 | | MW14 | M | 18-24 |
| HP1 | F | 18-24 | | SB2 | M | 55-64 |
| HP2 | F | 35-44 | | SB3 | M | 25-34 |
| HP3 | M | 18-24 | | SB5 | F | 25-34 |
| HP4 | M | 65+ | | SB6 | F | 45-54 |
| HP5 | M | 18-24 | | SB7 | F | 45-54 |
| HP6 | M | 25-34 | | SB8 | F | 25-34 |
| HP7 | M | 45-54 | | SB9 | M | 45-54 |
| HP9 | F | 45-54 | | SB10 | M | 55-64 |
| HP10 | M | 35-44 | | SB12 | F | 18-24 |
| HP11 | M | 25-34 | | SB13 | M | 55-64 |
| HP12 | F | 55-64 | | | | |
| LK1 | F | 25-34 | | | | |
| LK2 | M | 18-24 | | | | |

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