Energy Research & Social Science 109 (2024) 103403

Contents lists available at ScienceDirect

Energy Research & Social Science

journal homepage: www.elsevier.com/locate/erss

Original research article

Consumer preferences for business models with multiple electricity suppliers: Online choice experiments in the United Kingdom

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A R T I C L E I N F O

Keywords:
Local energy
Multiple suppliers
Peer-to-peer energy trading
Smart tariffs
Electric vehicle tariffs
Adaptive choice-based conjoint

A B S T R A C T

Under the UK's 'supplier hub principle', consumers have a single, licensed electricity supplier at a time that interfaces between the consumer and the energy system. Allowing consumers to have multiple electricity suppliers at a time is a proposed solution to enabling models such as peer-to-peer trading, local electricity supply, and managed operation of smart appliances and vehicle charging. This would allow engagement with innovative energy models whilst having a large-scale supplier meeting remaining demand. However, there is limited evidence regarding how consumers would respond to the complexities of buying electricity from multiple suppliers. We conducted three online Adaptive Choice-based Conjoint experiments on a nationally representative sample of the UK population (n = 1438, across three studies) and one using a sample of UK electric vehicle owners (n = 466). Participants were presented with one of four use cases of multiple-supplier models: local energy, peer-to-peer, smart home tariffs, and electric vehicle tariffs. The experiments measured participants' interest in buying a portion of their electricity from the presented model and tested the acceptability of various aspects of interacting with multiple suppliers. Participants showed extremely high interest in all use cases tested, although engagement was lower when the tariff was recommended by an entity involved in delivering it. Overall, use cases facilitated by multiple suppliers had high acceptability, but long contracts, third party involvement, and multiple bills reduced stated likelihood of engagement. This implies that, whilst consumers would like the benefits delivered by multiple suppliers, there is reluctance to accept additional complexity these market arrangements would bring.

1. Introduction

In the transition to smart, low-carbon energy systems, energy retail markets are evolving. New business models are emerging to manage electrification and intermittent renewables [1]. Actors not traditionally involved in energy supply are entering the market: electric vehicle (EV) manufacturers and smart appliance manufacturers are expressing an interest in providing flexibility services and bundling their products with energy supply [2–4]. End-users are also taking more active role in the energy system [5,6]. For example, local energy companies are selling energy from locally owned assets, often with social goals [7], and households with solar PV can sell surplus energy to friends and neighbours in a model known as "Peer to Peer Energy Trading" (P2P) [8,9]. New business models for integrating prosumers (who both produce and consume electricity) into the grid are also being explored, ranging from more traditional approaches such as Feed-in-Tariffs, net metering, and self-consumption, to more innovative aggregation, energy-as-a-service, demand response, and energy trading models [10]. These trends are creating regulatory challenges - and changing what it means to be an energy supplier [11].

Under current regulations, alternative value propositions are difficult to realise [11–14]. In the United Kingdom (UK) and other energy markets, energy suppliers act as an interface between end users and the wider energy system. Domestic consumers must have only one electricity supplier, who buys energy from the wholesale market to sell to their customers [15]. Obligations attached to supply licenses can be prohibitive for non-traditional suppliers with a specific geographic or demographic target market [2,13]. This single supplier model has been identified as a barrier to P2P and local energy markets [14,16,17], as well as for innovative companies looking to offer bespoke value propositions (see [4,14,18]). It is possible to partner with an existing licensed supplier (see e.g. [19]) or, in the UK and some other countries, to conduct time-limited trials that go beyond the current scope of regulations in a 'regulatory sandbox' [20,21]. However, sandbox trials are challenging to scale, given that they inherently break regulations [21], and relying on existing suppliers for partnerships can lock in market

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https://doi.org/10.1016/j.erss.2023.103403
Received 8 November 2022; Received in revised form 12 December 2023; Accepted 19 December 2023
Available online 24 January 2024

power for the larger supplier. As energy market actors become increasingly diverse and small scale, regulatory innovation will be required [2,11,22].

One proposed solution involves allowing domestic consumers to have more than one electricity supplier at a time [24]. A so-called 'multiple supplier model' or 'multi-party supply' was formally proposed in the UK [24] and has been discussed internationally, for example in New Zealand [25], the Netherlands [26], and other European countries [3,16]. This would allow consumers to engage with innovative business models whilst still having a national scale supplier to meet remaining electricity demand.[1] However, there is limited evidence regarding how consumers might respond to more complex energy market arrangements involving multiple suppliers [27,28].

This paper aims to understand UK consumers' attitudes towards getting electricity from multiple suppliers and the factors that impact willingness to engage. This research focuses on four key use cases that could be facilitated by multiple electricity suppliers: local energy; P2P energy trading; smart home tariffs; and electric vehicle tariffs. Four adaptive choice based conjoint (ACBC) studies were conducted in the UK, each focusing on one of these use cases with a total sample size of N = 1904. Although this paper examines the UK context, where discussions of multiple suppliers have advanced the furthest [24], findings are relevant to other liberalised electricity markets. Notably, UK consumers can already have different suppliers for gas and electricity; this paper discusses multiple suppliers for electricity only.

Section 2 provides a brief overview of the regulatory context and discusses broader literature on consumer attitudes towards new energy business models, highlighting a gap in the literature around interaction with multiple suppliers. Section 3 introduces the ACBC methodology and describes the data collection and analysis processes. Section 4 presents and discusses results from all four experiments. Section 5 concludes and discusses policy implications.

2. Background

2.1. Regulatory context

A regulatory change was proposed in the UK that would have enabled a particular form of multiple supplier model, through a change to the Balance and Settlement code (BSC),[2] which would have allowed electricity volumes through a single BSC meter to be split between different trading parties [24]. This change was known as P379 and would have enabled domestic consumers to have one 'primary' supplier, as well as taking on any number of additional 'secondary' suppliers offering non-traditional energy business models. Examples of secondary suppliers fall into two categories: those facilitating localisation of supply e.g. by allowing participants to get a portion of their electricity from a P2P trading network or a local energy supplier; and those supplying energy or services only to a particular asset [18,24,27]. Early industry reports anticipated benefits such as savings on network management and reinforcement, deployment of smart energy technologies at the grid-edge; renewable technology usage; smart meter take-up; and consumer engagement [24,24]. However, P379 was withdrawn in 2021 due to a lack of evidence that this modification would deliver these benefits, given high uncertainty surrounding consumer uptake of multiple suppliers [27], the costs of disruption, and concerns that additional complexity could create challenges for consumer engagement and supplier accountability [30–32].

Regulatory changes under assessment or already implemented in the UK could create interactions with multiple entities without P379 [33]. These include allowing behind-the-meter assets (e.g. EVs, heat pumps, solar PV, smart appliances etc.) within a property to be metered and settled individually [34], increasing the accessibility of BSC data [35], and facilitating access to wholesale markets for flexibility dispatched by Virtual Lead Parties, a form of aggregator providing balancing services only [36]. This gives consumers an alternative route for selling energy flexibility, bypassing their energy supplier. Combined, these developments begin to challenge the supplier hub model that centres on a single supplier-consumer relationship. Similarly, in the EU, under the Renewable Energy Directive II, European citizens have the right to buy and sell renewable electricity directly from one another or third parties - although it remains unclear how this will be interpreted by EU member states [16]. As these developments come into force and new business models emerge, it is likely that future energy consumers will have interactions with multiple entities, even if these do not take the form of licensed suppliers. This paper uses P379 as a starting point, but focuses on a broader definition of multiple suppliers, taking this to mean business models in which consumers receive energy supply or services from an entity or entities in addition to their usual energy supplier, to explore how various configurations of new market arrangements could affect engagement with such business models.

2.2. Use cases facilitated by multiple electricity suppliers

Several business models have been identified as potential use cases of multiple suppliers. *Specialist suppliers* would support new market entrants who wish to serve a specific part of a customer's load. This includes: EV, heat pump, or smart appliance manufacturers who wish to sell their product bundled with supply of the electricity needed to use it; specialist suppliers offering flexibility services associated with specific assets; or having different customers for different parts of the load (e.g. billing a company for electricity used to charge an employee's company EV at home). Benefits of these models included expanding consumers' access to new energy services, as well lower network costs and reduced bills for consumers [13,27]. *Local energy*[3] involves locally based customers buying a portion of their energy from local electricity generation projects through a local supplier. Similarly, *P2P energy trading* allows trading of electricity between local prosumers (e.g. households or businesses with solar PV) and consumers. As well as supporting integration of decentralised renewables into the grid and reducing network constraints at peak times, effective deployment of local energy and P2P can also help achieve social policy goals, such as empowering consumers, alleviating fuel poverty, and strengthening community ties [5,7,37]. P2P has the added advantage of creating a route for prosumers to sell their surplus energy, beyond feed-in-tariffs [5,10].

It would be possible for these models to be offered through partnerships or innovative tariffs with existing suppliers (e.g. [19,38]). However, this can result in less attractive value propositions and entrench market power for larger suppliers. For example, participation in community energy schemes currently requires all participants to switch to the same licensed supplier, which was identified as a barrier to engagement in a recent trial [39]. The logic of allowing these non-traditional suppliers to have unilateral contracts with consumers, without having to rely on existing suppliers, would be to open market competition and provide them with an independent route to market. The implementation of a form of multiple suppliers has been identified as important for removing barriers to decentralised energy innovation [14,16] and could accelerate the deployment of innovative business

[1] Note: Multi-party supply is technically possible through bilateral meter splitting arrangements between two suppliers, but this is not economically viable for domestic supply.

[2] The BSC is "a legal document which defines the rules and governance for the balancing mechanism and imbalance settlement processes of electricity in Great Britain" [29].

[3] CEPA use the term Community energy to refer to this concept; we use the broader term local energy

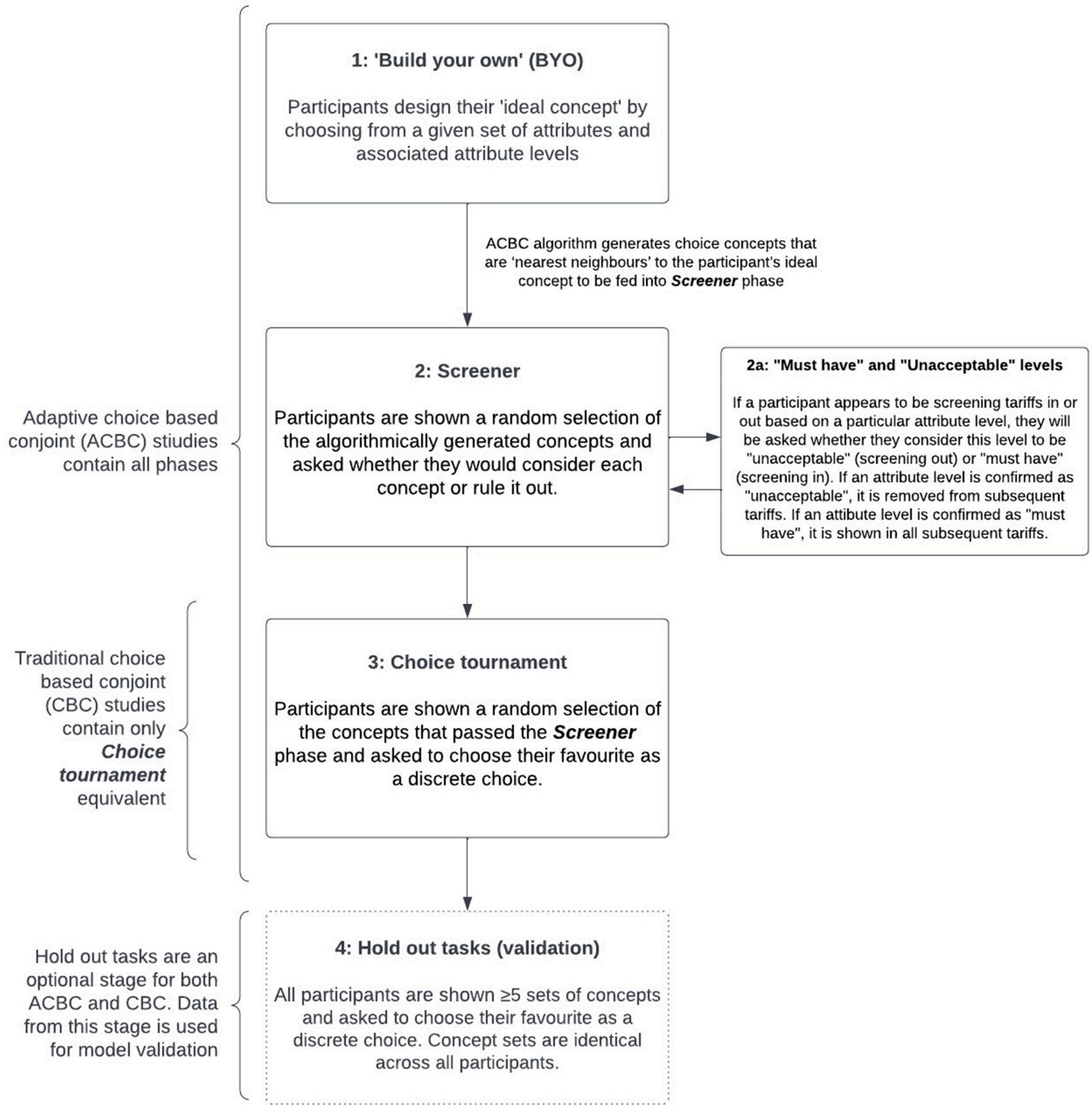


Fig. 1. Summary of ACBC experiment process.

models to achieve decarbonisation more quickly than reliance on incumbent systems [14].[4]

2.3. Consumer engagement with innovative energy business models

As these new business models develop, it is important to understand which market arrangements are most attractive to consumers. A growing body of literature is indicating high consumer interest in new energy business models. Hall et al. [1] examined consumer interest in four new energy business models compared to a 'same but smarter' control group. The authors found substantial appetite for some models, including P2P and a model including high electrification and automated DSR, although results differed between demographic groups. Evidence also suggests positive attitudes towards more localised approaches to buying energy, such as P2P (see [5]) and local energy suppliers [40]. Several studies in Germany [41–43], where municipal supply is relatively common, demonstrate higher willingness to pay for electricity that is generated locally, although it is unclear whether these findings would generalise to the UK market. Regarding specialised suppliers, work by Nicolson et al. [44] also highlights that hypothetical uptake of time-of-use (ToU) tariffs is higher among EV owners when it is marketed as a specialised "EV tariff".

However, existing literature typically presents new energy business models in the context of the current single supplier framework, despite the likelihood that consumer-supplier relations will become more complex in future energy markets [11]. Few studies explicitly include multiple supplier aspects (see [27]). Two nationally representative survey experiments conducted by Watson et al. [28] offer empirical evidence on consumer attitudes towards 'adding on' a local energy supplier to their current tariff in a multiple supplier model. Results indicated extremely high interest and participants were more likely to get a proportion of their supply from a local energy company than they were to switch to a new local energy supplier. Similarly, Fell et al. [45] conducted a nationally representative survey experiment to examine public demand for P2P under varying conditions, including different proportions of electricity being supplied by the P2P network. Findings

[4] There are some challenges that multiple suppliers alone would not address. For example, although a community energy scheme or P2P model could be exempt from supply licence requirements if the amount of electricity generated falls below the threshold of 2.5 MW, some secondary suppliers would still either require a supply licence or partnership with a licensed supplier to deliver their business model - for example if the total volume of electricity an EV or heat pump supplier was providing volumes to all of its customers was too large to warrant an exemption [24]

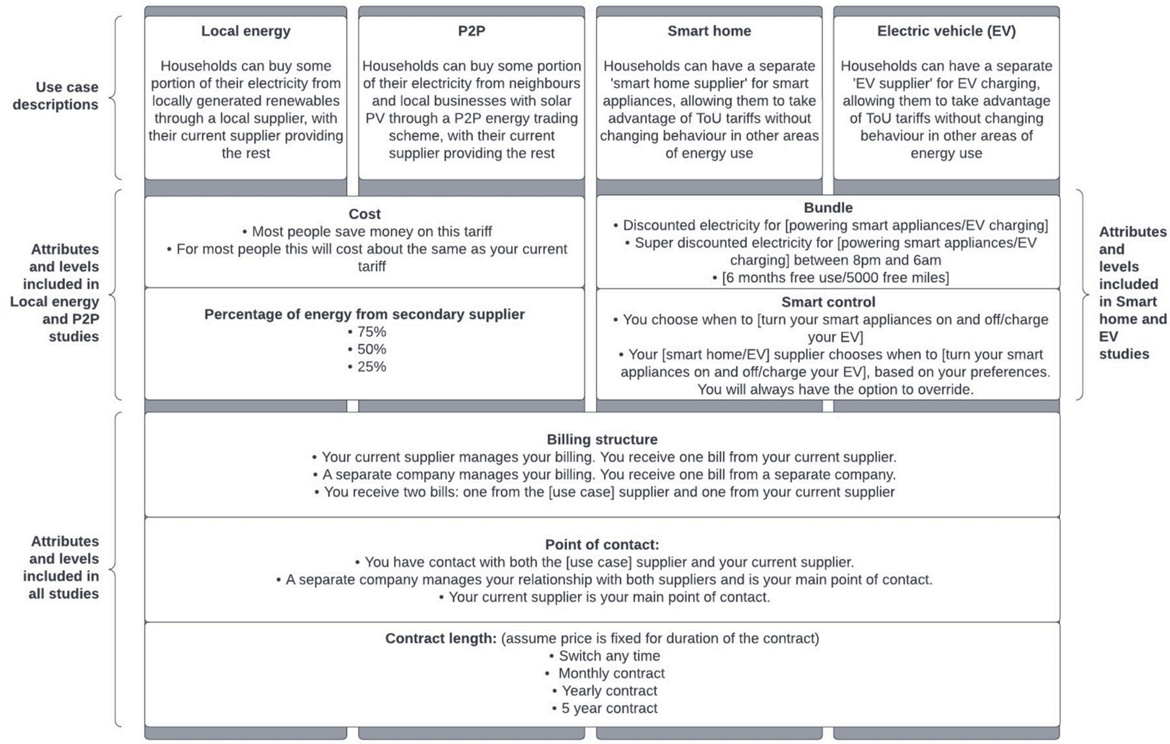


Fig. 2. Summary of use case descriptions, attributes and associated levels.

from both studies indicate that there is consumer interest in having a portion of energy provided by local energy or P2P networks. Nonetheless, neither study examined the practicalities of handling multiple suppliers, for example dealing with multiple points of contact or multiple bills and whether these aspects would be (un)appealing for consumers.

There is reason to expect an interaction with multiple suppliers to impact on the uptake of new energy business models. Whilst cost related concerns tend to dominate reasons for energy market engagement [46], non-financial factors have also been associated with remaining with incumbent suppliers. The complexity and hassle of switching is a frequently cited barrier to tariff switching [46,47], which risks being exacerbated by multiple suppliers [30]. Other threads throughout this literature include the importance of the way in which the offer is framed (see [48] for comprehensive discussion). Another aspect includes presentation of the offer by a trusted actor [49,50]: Tyers et al. [51] found that consumers were significantly more likely to switch tariff when approached by their current supplier - a finding supported in the multiple supplier context by Watson et al. [28]. Positive relationships with the current energy supplier have also been associated with remaining with incumbents [49,52]. However, it is unclear how this all translates to the context of multiple suppliers – and if policies such as P379 were to be reconsidered, it would be important to understand how to design energy retail market arrangements in a way that would not adversely impact consumer engagement.

This paper offers empirical evidence towards this aim by answering the following research questions:

1. How attractive are use cases facilitated by multiple suppliers to UK consumers?
   RQ1a: How likely would participants be to engage with a multiple supplier tariff?
   RQ1b: How do recommendations from different entities affect the likelihood of engaging with multiple supplier tariffs?
2. Which aspects of interacting with multiple electricity suppliers impact participants' willingness to engage with key use cases of multiple suppliers?
   RQ2a: Which features of a multiple supplier model are most/least attractive to participants?
   RQ2b: Which features of an interaction with multiple suppliers are most important to participants?

The remainder of this paper presents four experiments, each answering these research questions in the context of a different use case facilitated by multiple suppliers: local energy, P2P, smart home tariffs, and EV tariffs.

3. Methods and data

Procedures are reported following CONSORT guidelines.

3.1. Trial design, interventions, outcomes randomisation

Four adaptive choice based conjoint (ACBC) studies were developed using Sawtooth's Lighthouse software and delivered online. Each experiment applies the same format and method, focusing on a different use case facilitated by multiple suppliers (local energy; P2P; smart home tariffs; and EV tariffs). Results are discussed for each use case individually and in terms of commonalities across different use cases. ACBC is a stated preference method increasingly being adopted in the energy field (e.g. [42,53,54]). Stated preferences are commonly used to measure choices between alternatives that do not yet exist, which is appropriate for multiple electricity suppliers [55]. Conjoint analysis is "a class of survey-experimental methods that estimate respondents' preferences given their overall evaluations of alternative profiles that vary across multiple attributes" [[56], p. 20]. Participants are presented with a series of concepts, which describe variations of a product or service. Each concept consists of a set of attributes, which are quantitative or qualitative features of the concept. Attributes are specified by a set of levels, which are randomly varied to generate concepts. ACBC is a form

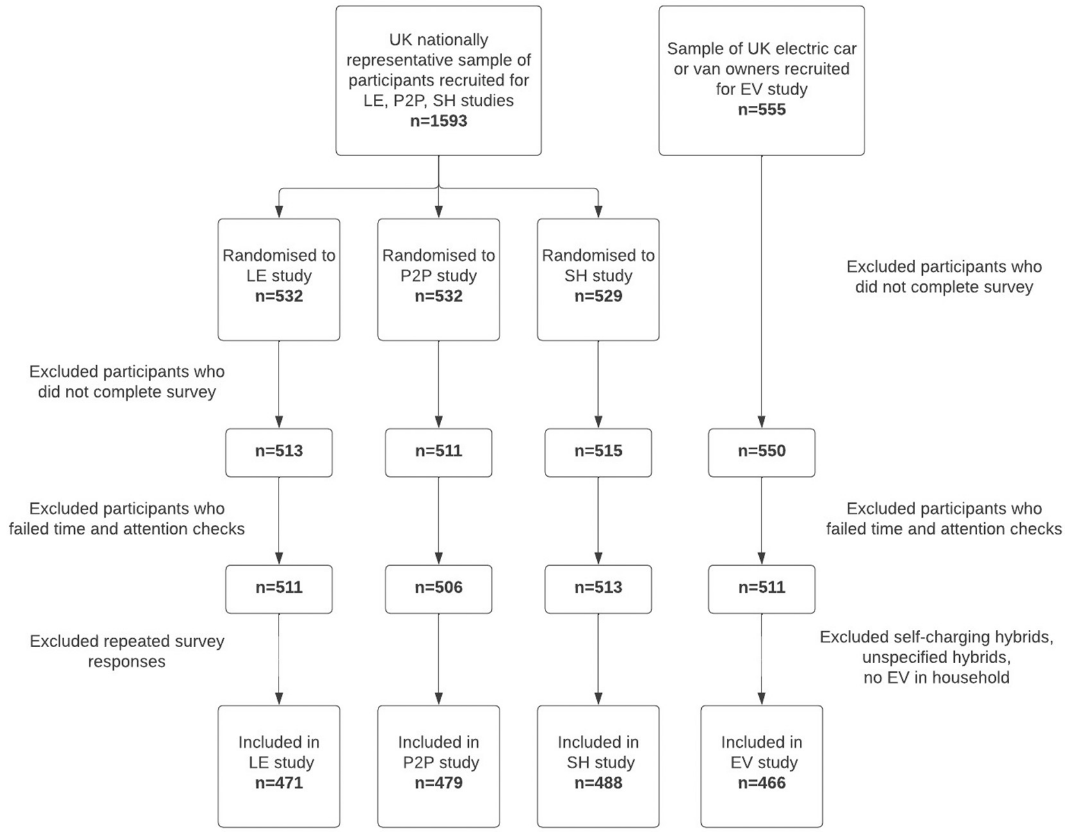


Fig. 3. Summary of participant exclusions.

of 'choice based conjoint studies' (CBC), which use a discrete choice as the outcome variable in each decision (i.e. participants choose a single outcome from a range of possibilities). Discrete choices force participants to take trade-offs more seriously and are rooted in theories of human behaviour i.e. Random Utility Theory [57] (see Methods Appendix for discussion).

An ACBC study consists of three sections: 1: '*Build-Your-Own*' (*BYO*); 2: *Screener*; 3: *Choice tournament*. These are described in Fig. 1.

A typical CBC study would consist only of the *Choice tournament*, with the option of holdout tasks for model validation. The 'adaptive' elements were developed to improve on some of the limitations of traditional CBC analysis (discussed in full in the Methods Appendix). Asking participants to first design their own tariff in the BYO stage helps improve the efficiency of the conjoint design through an informed approach to parameter selection. By focusing on the ideal tariff's 'near-neighbours', ACBC varies fewer attributes at once, reducing the number of stimuli under consideration [58]. The aim of the *Screener* phase is to align the experiment design with theories of decision-making behaviour, by allowing the software to detect when participants are screening tariffs in and out based on a single attribute level. ACBC studies are also reported to be more relevant, engaging, and enjoyable [59–61], and perform equally well or better than traditional CBC studies in terms of model accuracy [59–63]. They also produce more data per participant, including useful data for policy-makers, such as the percentage of participants that consider an attribute level unacceptable. However, these advantages come at the price of longer survey times [58].

After the ACBC experiment, participants were presented with what the software had determined to be their 'winning tariff' based on the choices they had made. They were asked whether they would choose to get electricity from multiple suppliers on this tariff if it were available to them in real life. In a follow-up questions, participants were asked to imagine that the tariff had been recommended to them by a series of entities and indicate how likely they would be to engage under each circumstance. They were then asked a series of demographic questions. Finally, participants were given an opportunity to share their thoughts in a free text box. The survey is reproduced in the Methods Appendix.

3.1.1. Use case and attribute identification

We identified policy and commercially relevant use cases of multiple electricity suppliers to test through a series of semi-structured, individual expert interviews, conducted in summer 2020 [18].

Eight experts were interviewed, representing policy, regulation, industry, and academia. As an introduction, interviewees were asked a series of questions about future energy retail market landscapes, the findings of which have been published in [18]. They were then shown suggested use cases of multiple suppliers, as well as an initial set of attributes and levels for the choice experiments, drawn from work on P379 [24,27,33] and the broader literature presented in Section 2.3. The final selected use cases, as well as their associated attributes and levels were refined through discussions with the expert interviewees. An overview providing descriptions of the use cases tested and their associated attributes and levels is given in Fig. 2.

3.2. Participants

Data was collected using Prolific, a research recruitment platform. Participants had to be at least 18 years old and living in the UK. They were paid £1.88, an average reward of £9.10/h. For the local energy, P2P and smart home use cases, the sample was stratified by age by gender and ethnicity to achieve national representation across these demographics. Data collection for these studies took place between 11/10/2021 and 14/10/2021.

After consenting to take part, participants were randomly assigned to the local energy, P2P or smart home study. Participants were allocated

Table 1
Descriptive statistics.

	Full sample[a]	Local energy	P2P	Smart home	EV[b]	UK adults
Sample size	n = 1438	n = 471	n = 479	n = 488	n = 466	
Gender						
Female	52 %	47 %	53 %	55 %	54 %	50 %
Male	47 %	52 %	46 %	44 %	45 %	49 %
Non-binary or prefer to self-describe	1 %	0 %	1 %	1 %	1 %	–
Prefer not to say	0 %	0 %	0 %	0 %	0 %	–
Age						
18–24	11 %	11 %	11 %	9 %	20 %	10 %
25–34	20 %	21 %	20 %	20 %	26 %	16 %
35–44	19 %	20 %	20 %	17 %	30 %	15 %
45–54	16 %	16 %	14 %	17 %	15 %	16 %
55–64	23 %	23 %	23 %	22 %	7 %	15 %
65–74	9 %	9 %	9 %	9 %	2 %	12 %
75+	1 %	1 %	1 %	2 %	0 %	10 %
Prefer not to say	0 %		1 %	0 %	0 %	–
Tenure						
Own (either own outright or with mortgage)	62 %	61 %	63 %	62 %	71 %	64 %
Rent privately	24 %	26 %	23 %	24 %	20 %	18 %
Rent from council (local authority) or housing association	9 %	8 %	10 %	17 %	3 %	8 %
Live here rent free	2 %	3 %	2 %	2 %	4 %	–
Other	1 %	2 %	1 %	1 %	1 %	–
Don't know/prefer not to say	0 %	0 %	1 %	0 %	1 %	–
Income						
Below £10, 000	5 %	6 %	6 %	5 %	1 %	5 %
£10, 001 to £20, 000	14 %	15 %	14 %	15 %	6 %	21 %
£20, 001 to £30, 000	19 %	20 %	18 %	20 %	14 %	25 %
£30, 001 to £40, 000	14 %	14 %	16 %	13 %	13 %	19 %
£40, 001 to £50, 000	13 %	11 %	14 %	13 %	15 %	12 %
Above £50, 001	26 %	27 %	25 %	26 %	46 %	18 %
Don't know/prefer not to say	8 %	8 %	8 %	8 %	6 %	–
Education						
University undergraduate or higher	54 %	54 %	51 %	68 %	56 %	–
A level	30 %	32 %	30 %	28 %	24 %	–
GCSE	15 %	13 %	18 %	14 %	8 %	–
None of above	1 %	1 %	1 %	1 %	0 %	–
Prefer not to say	0 %	0 %	1 %	0 %	0 %	–

[a] Full sample was randomly divided into the Local Energy, P2P, and Smart Home studies.
[b] EV study was conducted on a separate sample of EV owners only.

on a "least filled" basis (i.e. assigned to the study with the fewest participants when they entered the survey). To handle multiple people accessing the survey at once, it was assumed that 80 % of those assigned to a study would complete the survey.

To test the EV use case, a sample of participants with experience of electric car or van ownership or leasing was recruited using a screening question from Prolific. The sample was not restricted only to current EV owners but also included those who had previously owned or leased an EV (either fully electric or plug-in hybrid), had access to an EV through work or a car sharing club, or were waiting for a purchased EV to arrive. Self-charging hybrids were excluded. Data collection for this study was conducted between 21/06/2022 and 05/05/2022.

Power analyses for conjoint experiments are more complex than those for standard factorial experiments as they combine within and between participant measures [64]. This becomes more complex for ACBC, as the survey adapts for each participant. Orme and Chrzan [65] suggest using a sample size that can detect main effects of 0.05 or less; simulations run using Sawtooth software found that a sample size of 500 would allow standard errors of approximately 0.02 be detected.[5]

Across all studies 1904 participants gave valid responses: 471, 479, 488, and 466 for the local energy, P2P, smart home, and EV studies respectively. Fig. 3 shows exclusions per study. Participants were rejected if they met both exclusion criteria: 1) failed the attention check question and 2) completed the survey in under 6 min.[6] Outlier exclusion was not performed.[7] Due to a server error, 93 participants completed the study twice. Only their first response was used in the analysis, to avoid training effects. Questions about EV ownership and charging were included in the EV study to validate the screening question. Participants who gave conflicting answers were sent a follow-up message. Those who did not respond or reported having no EV, an unspecified hybrid, or a self-charging hybrid were excluded.

Survey design, including the random allocation generation, was implemented by the lead author. Participant recruitment was implemented by Prolific. There was no blinding in this study.

3.3. Statistical methods

In line with best practice [67], all analyses were pre-registered at doi:10.17605/OSF.IO/PJNE5. Deviations from the pre-analysis plan are discussed when appropriate.

To answer RQ1a (how likely would participants be to engage with a multiple supplier tariff?), participants were presented with their 'winning tariff' and asked to indicate their likelihood of engaging, using a 7-

[5] Note: the pre-analysis plan specified a sample size of 500 per study; due to exclusions, this was not reached. Additional simulation analysis found that a sample size of 466, the smallest sample size across all studies was still able to detect standard errors of 0.0271 or less.

[6] In the preregistration, it was stated that participants would be excluded if they failed the attention check question. This was changed to participants who took <6 min to complete the survey and failed the attention check question, in accordance with Prolific's guidance on participant rejection. This change was made before viewing any data.

[7] The hierarchical Bayesian model used to analyse the data down-weights participants who give extreme responses. Outlier exclusion is therefore not recommended and outliers are unlikely to adversely affect the data [66].

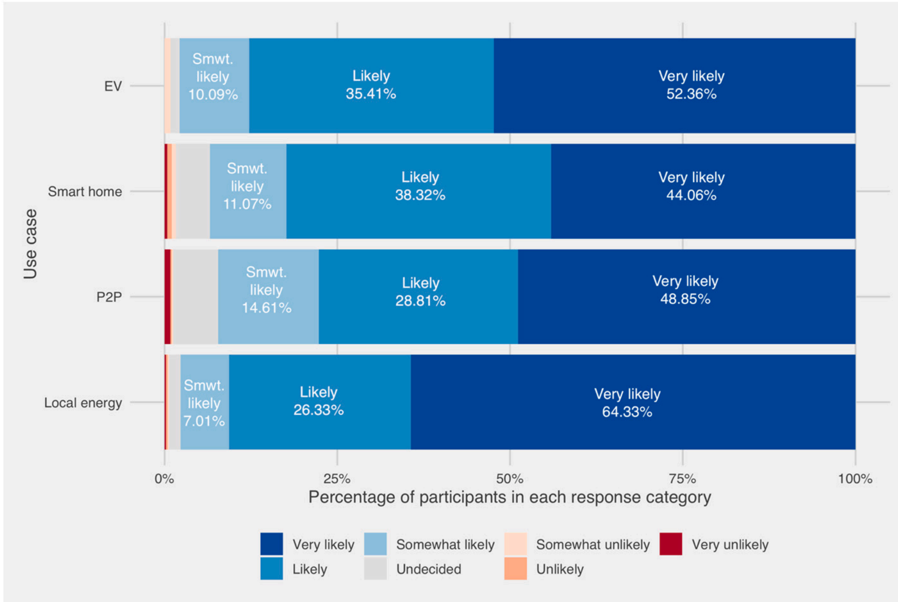


Fig. 4. Self-reported likelihood of engaging with 'winning' multiple supplier tariffs by use case.

point Likert scale from 'very unlikely' to 'very likely'.[8] The mean average and standard deviation of responses to this question were analysed. Results are supplemented with qualitative comments from the free text boxes. All comments were coded thematically by a single coder. Questions relating to survey administration or giving feedback on wording or response options of demographic questions were noted and excluded from the analysis. Given that the free text question was optional and responses does not represent the full range of participants in the study, comments were treated as supplementary information only, and are discussed in terms of the themes that arose, without reference to the number of times each theme was mentioned.

RQ1b (how do recommendations from different entities affect the likelihood of engaging with multiple supplier tariffs) was tested through the Bayesian equivalent of a Chi squared test. For each recommending entity, the total number of participants reporting that they would engage (i.e. chose "somewhat likely" or higher) was put into a contingency table and compared against the proportion switching with no recommendation. Undecided was classed as would not engage. A Bayesian test of association was run using version 0.9.10-1 of the BayesFactor package, with default priors and a joint multinomial sampling plan [68].

Exploratory evidence from Watson et al. [28] indicates that participants were more likely to engage with local energy in a multiple supplier model when it was recommended to them by their current supplier in partnership with the new local energy supplier. This will be formally tested in the following hypothesis:

H1: Participants will report that they would be more likely to switch to the tariff presented if it were recommended by their current supplier in partnership with the new local supplier compared to no recommendation.

To answer RQ2a (Which features of a multiple supplier model are most/least attractive to participants?), sample average part worth utilities were derived for each experiment using a hierarchical Bayes estimation model (HB) [69]. The part-worth utility score associated with an attribute level is a quantitative measure of how much participants value having this attribute level featured in the tariff (higher utility score = greater value). Part-worth utility scores are calculated for each respondent and then averaged across the sample. The 'hierarchical' (i.e. multilevel) component of the model allows heterogeneity between respondents to be accounted for, offering an improvement on aggregate models such as OLS regression or multivariate logit models traditionally used to analyse conjoint experiments [69,70]. The 'Bayesian' component of the model allows it to 'borrow' data from the entire sample in order to estimate probability distributions of individuals' parameters. In other words, the HB model estimates individual part worth utilities by estimating how different that individual is from others in the sample (see Methods Appendix for further detail).

RQ2b (which aspects of an interaction with multiple suppliers are the most important to participants?) is answered through analysis of 'attribute importance scores'. The importance score reflects the degree of variation between the 'best' and 'worst' level of an attribute (i.e. the larger the difference, the higher the importance score). Given the limited evidence on consumer interactions with multiple electricity suppliers, the choice analysis is primarily exploratory. Cost is the only exception as, according to classic rational choice theory, we can expect consumers to prefer options that are cheaper. The following hypothesis is tested in the local energy and P2P studies: H2: The average part-worth utility of the attribute level *you will save money on this tariff* will be higher than that of *this will cost about the same as your current tariff*.

Although previous studies have used frequentist statistical tests to test for differences in attribute levels (e.g. [42]), as the HB model is based on simulated draws, Bayesian statistical tests are more appropriate [65]. For ontological consistency, a Bayesian approach is taken in all analyses.

4. Results and discussion

4.1. Sample description and comparison with national demographics

Table 1 shows the demographic composition of both sample and national demographics for comparison with the nationally representative sample.

The sample for the local energy, P2P, and smart home studies was compared against mid 2020 ONS population estimates [71], the 2021 UK housing review (based on 2019 figures) [72] and the Household finances survey (for the financial year ending 2020) [73]. The sample was broadly representative in terms of age and gender. Those with an income level of £10,001–£20,000 and £20,001–£30,000 are slightly underrepresented (14 % of sample compared to 21 % of UK adults) and those with

[8] Analysis of demographic characteristics was also included in the pre-analysis plan. This is presented in the Results Appendix.

Table 2
Impact of recommendations on likelihood of switching.

Use case	Recommendation impact (most likely to engage to least likely)					
Local energy	**No recommendation** Mean: 1.49 Would engage: 90.66	**Regulator** Mean: 2.36 Would engage: 61.57% BF: 1.18(e^{24}): 1	**Friend** Mean: 2.47 Would engage: 59.02% BF: 5.62(e^{27}) : 1	**Current supplier in partnership with local energy supplier** Mean: 2.62 Would engage: 52.01% BF: 7.66(e^{38}): 1	**Local supplier** Mean: 3.20 Would engage: 30.79% BF: 1.4(e^{83}): 1	**Local council** Mean: 3.29 Would engage: 30.57% BF: 4.85(e^{83}): 1
P2P	**No recommendation** Mean: 1.84 Would engage: 77.66%	**Regulator** Mean: 2.43 Would engage: 59.08% BF: 2.656 (10^{7}): 1	**Friend** Mean: 2.55 Would engage: 54.28% BF: 7.7 (10^{11}):1	**Current supplier in partnership with P2P platform** Mean: 2.74 Would engage: 44.89% BF: 1.36(e^{23}) : 1	**P2P platform** Mean: 3.15 % Would engage: 31.73% BF: 1.11(e^{45}) : 1	**Local council** Mean: 3.25 Would engage: 33.19% BF: 1.67(e^{42}) : 1
Smart home	**No recommendation** Mean: 1.83 Would engage: 82.38%	**Regulator** Mean: 2.57 Would engage: 54.30% BF: 6.38(e^{18}) : 1	**Friend** Mean: 2.65 Would engage: 49.80% BF: 7.5(e^{24}) : 1	**Current supplier in partnership with smart appliance manufacturer** Mean: 3.08 Would engage: 36.48% BF: 2.77(e^{47}): 1	**Smart appliance manufacturer** Mean: 3.41 Would engage: 27.25% BF: 8.33(e^{67}): 1	–
EV	**No recommendation** Mean: 1.63 Would engage: 87.77%	**Friend** Mean: 2.42 Would engage: 60.52% BF: 2.21(e^{19}) : 1	**Regulator** Mean: 2.56 Would engage: 55.79% BF: 4.78(e^{25}): 1	**Current supplier in partnership with EV manufacturer** Mean: 2.84 Would engage: 42.27% BF: 7.7(e^{47}):1	**EV manufacturer** Mean: 2.98 Would engage: 38.63% BF: 1.04(e^{55}) : 1	–

Interpretation: Mean: 1 = very likely, 7 = very unlikely.
Would engage: % of sample selecting Likely, or Very likely.
BF indicates the odds in favour of a relationship between the recommendation and choice made, compared to no recommendation.

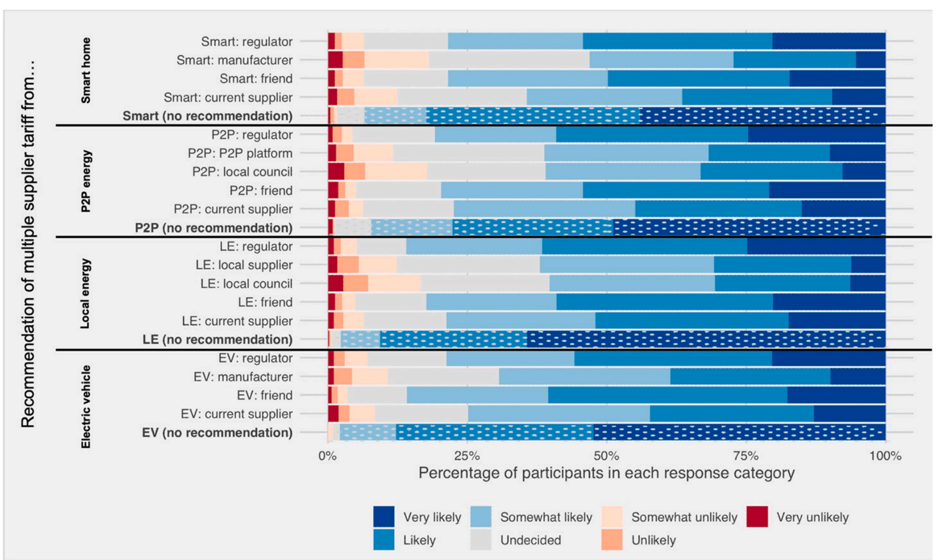


Fig. 5. Likelihood of engaging with multiple supplier tariffs with recommendations.

an income level of £50,001 and above are slightly overrepresented (26 % compared to 18 % of UK adults). Private renters are also slightly overrepresented (24 % compared to 18 % in UK population). No UK population data was available for living rent free. As the EV study sampled electric vehicle owners only, it was not designed to be nationally representative.

4.2. RQ1a: demand for use cases facilitated by multiple suppliers

RQ1a focused on assessing demand for each of the use cases facilitated by multiple suppliers. Fig. 4 shows participants' stated likelihood of engaging with each business model when presented with what the software determined to be their 'winning tariff'.

Self-reported likelihood of engaging with local energy was the highest, with a mean response of 1.49 (where 1 = very likely and 7 = very unlikely); for P2P and smart homes, the mean responses were 1.84 and 1.83 respectively. P2P had the most variable responses, with a standard deviation of 1.06, compared to 0.79 and 0.99 for local energy and smart home tariffs respectively. As the EV study focused on EV owners only, it should not be compared directly to the other models; the mean and standard deviation for the EV study were 1.63 and 0.79 respectively. Overall, responses to all models were overwhelmingly positive, indicating extremely high demand for these business models. This echoes findings from Watson et al. [28] as well as the literature indicating high demand for local energy [40], P2P [1,5,45] and electric vehicle tariffs [44].

398 participants across all studies chose to comment in the free text box at the end of the survey. As this question was optional, comments should be considered as supplementary insight and not representative. For local energy, comments highlighted financial benefits for local businesses, environmental benefits, a sense of community, the ability to identify the origin of electricity, and increased reliability through a secondary supplier. There was, however, a need for reassurance of the benefits and the financial health of the local energy company and some

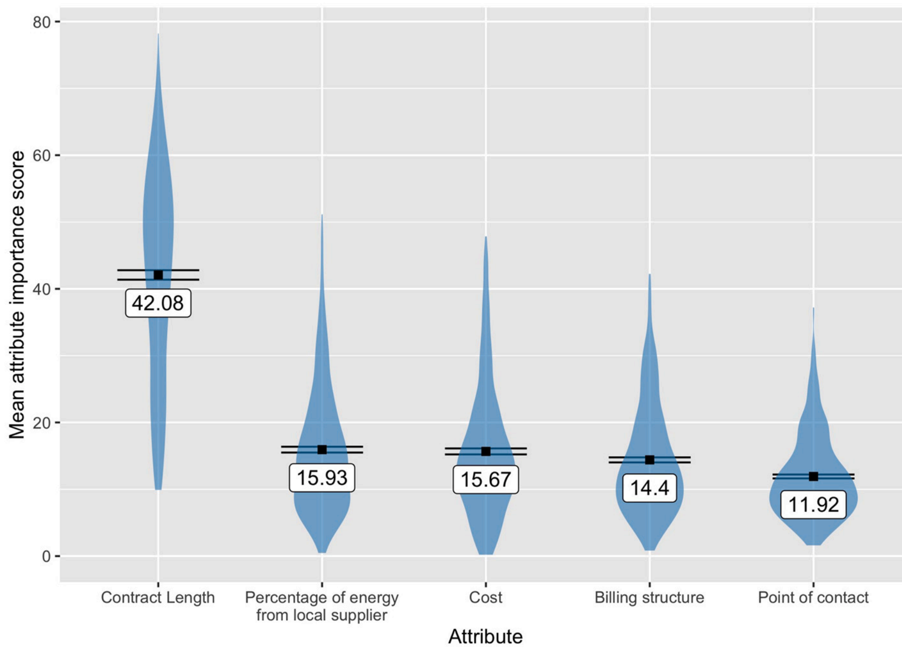


Fig. 6. Mean (indicated by a black square with 95 % CI) and distribution of importance scores for attributes in local energy study.

concern about the practicalities of meter splitting. Positive comments about P2P related to incentivising solar installation, locality, and profits for communities instead of companies. Concerns regarded the reliability of P2P, associations with cryptocurrency, complexity of dealing with multiple suppliers, and distrust of the community. Positive comments about the smart home tariff focused on lower costs, smart controls, convenience, and environmental benefits of saving energy. Positive comments about the EV tariff discussed saving money, supporting the integration of renewable sources of energy, and accessing financial and environmental benefits of ToU tariffs. For the EV and smart home tariffs, negative comments related to hassle and uncertainty of engaging with multiple suppliers, and distrust of energy suppliers and third-party intermediaries.

Overall, positive aspects of multiple suppliers were perceived to be the opportunity to save money, have increased choice, improved awareness of energy, and to encourage innovation in energy markets and break up monopolies. Concerns about multiple suppliers related to complexity, fears of inefficiency and increased cost, as well as a lack of accountability and uncertainty about how it would work in practice. These generally reflected the costs and benefits outlined in an independent Cost Benefit Analysis of P379, the proposal for multiple suppliers in the UK [27].

4.3. RQ1b: effect of recommendations on likelihood of switching

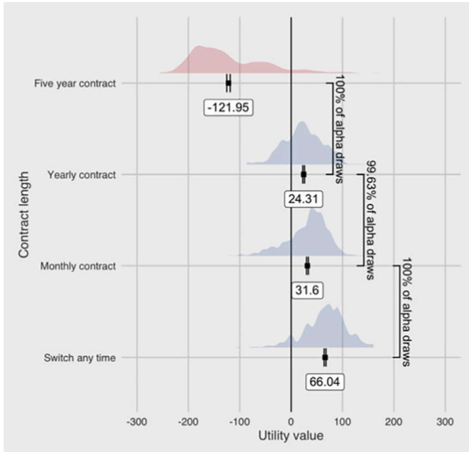
RQ1b focuses on whether recommendations from different entities influence the likelihood of engaging with the multiple supplier tariff. After being presented with their 'winning tariff', participants were asked to indicate how likely they would be to engage with it using a 7-point Likert scale (responses shown in Fig. 4). They were then asked to indicate how likely they would be to engage with that tariff if it were recommended to them by a series of entities. Table 2 shows how the entities recommending the tariff differed for each use case and the results from the Bayesian equivalent of a Chi squared test.[9]

Fig. 5 and Table 2 show the likelihood of participants engaging with each use case with a recommendation from a particular entity. Contrary to expectations, the effect of recommendations was always negative. For all recommendations, the Bayes factor indicates extremely strong evidence in favour of a relationship between the recommendation and the

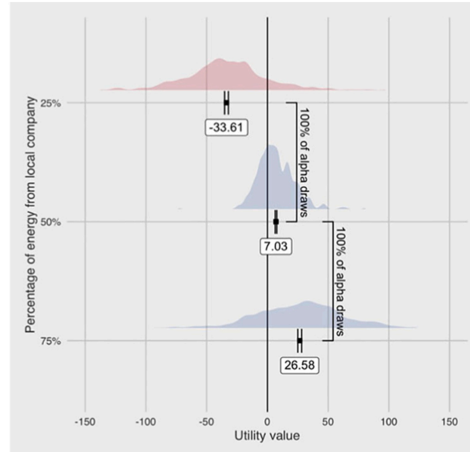
Table 3
Local energy study: Percentage of participants with each attribute level in their ideal tariff and winning tariff, and percentage of participants marking each attribute level as unacceptable.

	Selected in ideal tariff (%)	Featured in winning tariff (%)	"Unacceptable" (%)
Billing			
One bill from current supplier	38.22	43.10	0.42
Two bills	34.61	25.48	7.43
One bill from separate company	27.18	31.42	2.55
Percentage of energy from local supplier			
25 %	11.89	11.68	8.28
50 %	30.15	26.54	1.06
75 %	57.96	61.78	2.12
Length of contract			
Switch any time	56.69	55.84	0.85
Monthly contract	11.89	19.96	5.31
Yearly contract	27.60	18.90	7.64
Five year contract	3.82	5.31	57.32
Point of contact			
Current supplier main point of contact	25.05	35.46	1.27
Separate company main point of contact	26.33	27.39	2.97
Contact with both suppliers	48.62	37.15	3.61
Cost			
Same as current tariff	N/A	10.40	0.00
Save money	N/A	89.60	0.00

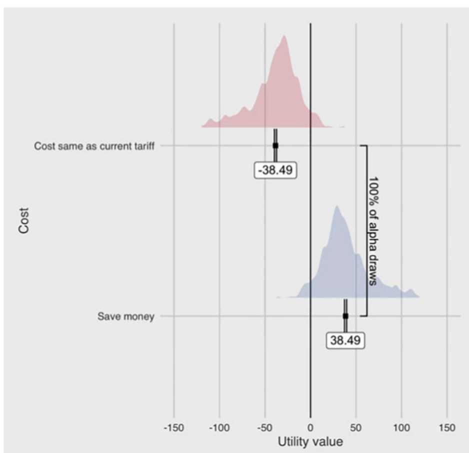
[9] The Frequentist equivalent of this analysis (i.e. Chi squared tests) is presented in the Appendix.



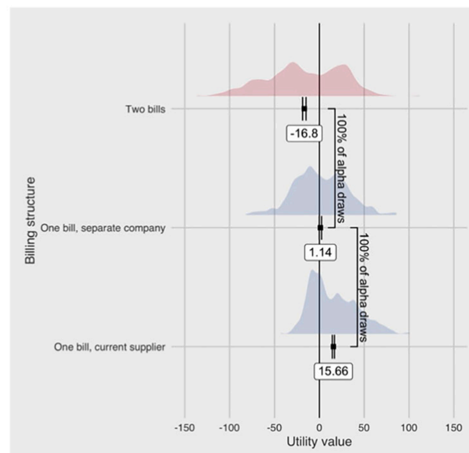
(a) Mean utility scores: contract length



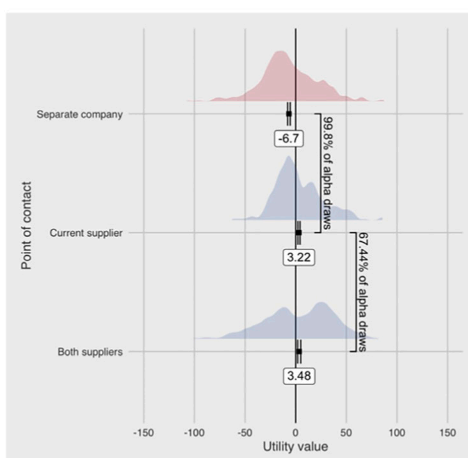
(b) Mean utility scores: percentage of energy from local supply



(c) Mean utility scores: cost



(d) Mean utility scores: billing structure



(e) Mean utility scores: point of contact

Fig. 7. Sample mean utility scores for attribute levels in local energy study (mean for each level shown by a black square with error bars indicating the 95 % CI on the mean) and distribution of individual responses. The percentage of alpha draws that differ between pairs of attribute levels indicates the confidence level that there is a difference between these levels.

choice made (compared to no recommendation).

The negative effect of recommendations is contrary to the exploratory finding from Watson et al. [28]: H1 (participants would be more likely to engage with a recommendation from the current supplier compared to no recommendation) is not supported. As the survey question with no recommendation included an explicit reference to the participant's 'winning tariff', whereas the recommendation questions referred only to 'this tariff', it is possible that participants associated the recommendations with a multiple supplier tariff in general, rather than their own winning tariff, which could account for this negative effect. This could also be due to presentation of the question: as a high proportion of participants answered "very likely" when the tariff was

Table 4
P2P study: Percentage of participants with each attribute level in their ideal tariff and winning tariff, and percentage of participants marking each attribute level as unacceptable.

	Selected in ideal tariff (%)	Featured in winning tariff (%)	Unacceptable (%)
Billing			
One bill from current supplier	42.38	45.82	1.04
Two bills	25.26	20.08	9.39
One bill from separate company	32.36	34.10	2.09
Percentage of energy from P2P			
25 %	24.84	25.31	3.76
50 %	49.48	35.77	1.25
75 %	25.68	38.91	5.43
Length of contract			
Switch any time	51.57	57.32	1.25
Monthly contract	18.37	17.99	5.22
Yearly contract	24.63	18.41	8.35
Five year contract	5.43	6.28	54.28
Point of contact			
Current supplier main point of contact	33.40	42.47	1.46
Separate company main point of contact	29.65	26.57	3.34
Contact with both suppliers	36.95	30.96	3.76
Cost			
Same as current tariff	N/A	7.95	15.87
Save money	N/A	92.05	0.21

presented without a recommendation, when asked the follow-up question with recommendations, these participants could only give the same answer or a comparatively less positive answer, which may have skewed the results.

In light of this ambiguity, it is more fruitful to focus on comparisons between the entities making the recommendations, rather than a comparison with no recommendation. Across all studies, recommendations from a friend or from the energy regulator had the least negative impacts. Recommendations from the local council (in the local energy and P2P studies only) and actors directly involved in delivering the multiple supplier model (i.e. the current supplier or the secondary supplier in partnership with the current supplier) typically had the most negative impacts. One explanation for this could be distrust of those with a perceived vested interest in promoting the use case. Distrust in the motives of those making recommendations could also account for the negative effects of recommendations in general. This could be exacerbated as these studies, in particular the EV study, were conducted at a time of turmoil and extremely low trust in the energy market [74].

4.4. RQ2: choice analysis

This section presents the results of the hierarchical Bayes choice models addressing RQ2a (which features of a multiple supplier model are most/least attractive to participants?) and RQ2b (which features of

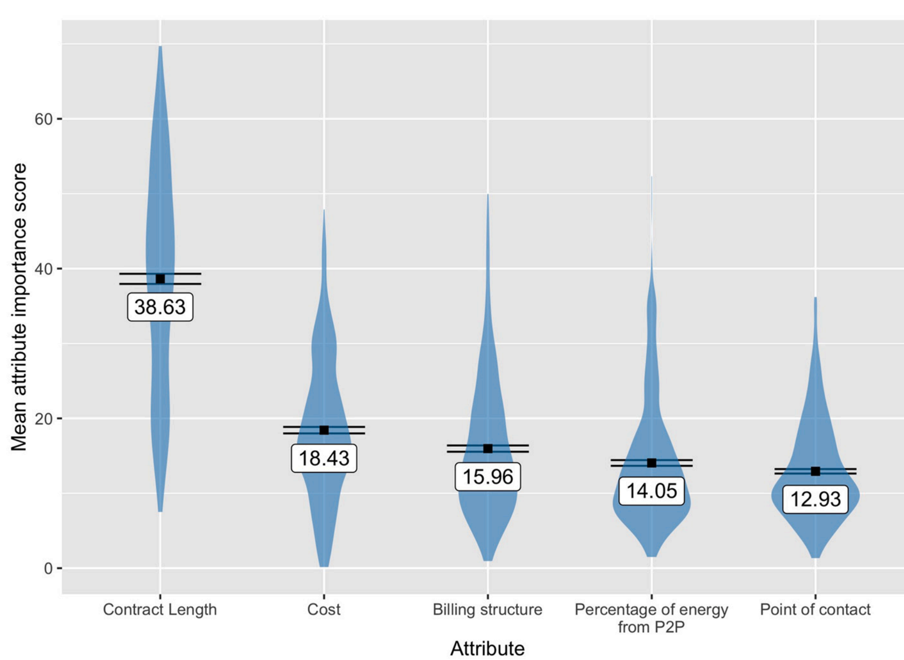


Fig. 8. Mean (indicated by a black square with 95 % CI) and distribution of importance scores for attributes in P2P study.

an interaction with multiple suppliers are most important to participants?).

4.4.1. Model fit

The survey designs had a D-efficiency of at least 0.962 for all respondents in the local energy study, 0.962 for the P2P study, 0.965 for the smart home study, and 0.965 for the EV study. This means that all studies were close to a full design (i.e. showing participants all possible combinations of attributes and levels) in terms of statistical efficiency [75]. The HB model was run using default alpha parameters and 100 k iterations of the algorithm, the first 50 k of which were discarded as stabilization iterations used for convergence. Otter's scaling method, which takes into account how the different sections of the survey feed into one another, was applied to estimate task specific scaling parameters [76] (see Methods Appendix for further explanation).

The Root Likelihood of the models were 0.71 for the Local Energy study, 0.70 for the P2P study, 0.69 for the Smart Home study and 0.69 for the EV study. This is indicative of a good fit and comparable with previous similar studies [42].

Holdout questions were used to validate the results of the study and test whether the calculated utility scores could correctly predict new choices. The accuracy of the model averaged over all respondents' five holdout questions within each study was: 57 % for the local energy study; 75 % for the P2P study; 72 % for the smart home study; and 72 % for the EV study.

4.4.2. Local energy

Fig. 6 presents sample mean average and distribution of the individual attribute importance scores for the local energy study. Table 3 presents the number of times each attribute level was chosen in the ideal tariff, featured in the winning tariff, and marked as unacceptable.[10]

Fig. 7 presents the mean utility score for each attribute level in the local energy study. The mean utility score for each attribute level is shown by a black square, with error bars indicating the 95 % confidence interval around the mean (see Results Appendix for tables). The distribution of individual utility scores is shown in the background. Higher utility scores are indicative of a greater preference for this attribute level.[11] For each pair of attribute levels, at least 95 % of alpha draws were higher for the preferred level unless explicitly mentioned otherwise (i.e. we can be 95 % confident that there was a preference for this attribute level compared to the next best level).

The most important attribute was *Contract length* with an importance score of 42.08, driven by the unpopularity of *five year contracts*, which had a utility score of −121.95 and was marked as 'unacceptable' by 57.32 % of the sample. *Switch any time* was the most popular attribute level.

All other attributes had similar importance scores, with *percentage of energy from local energy company* being the next most important, followed by *Cost*, *Billing*, and *Point of contact* in last place. In the *percentage of energy from local energy company* attribute, there was a preference for getting as much energy as possible from the local supplier, with *75 % of energy from the local supplier* having the highest utility value of 26.58 and *25 %* having the lowest at −33.61. 57.96 % of the sample chose *75 % from local energy* in their ideal tariff and it was featured in the winning tariff for 61.78 % of participants.

As predicted in H1, in the *Cost* attribute, *saving money* had a higher utility value than *costing the same* (38.49 compared to −38.49) and also featured in the winning tariff for 89.60 % of participants. For *Billing*, *one bill from the current supplier* was the most attractive level and *two bills* was the least attractive. For *Point of contact*, *Separate company as the main point of contact* was the lowest scoring attribute level, but there was no clear preferred level. Although *Contact with both suppliers* was chosen most often in the ideal tariff (48.62 %) and featured most frequently in the winning tariff (37.15 %), only 65.1 % of alpha draws were higher for *Contact with both suppliers* compared to *Contact with the current supplier only*, so we can only be 65.1 % confident that there was a preference for this attribute.

4.4.3. P2P

Table 4 and Figs. 8 and 9 present results for the P2P study. For all attribute levels, >95 % of alpha draws were higher/lower than the next closest level.

In the P2P study, *Contract length* was again the most important attribute again, with a score of 38.63. *Five year contracts* were extremely unpopular, with 54.28 % marking them as unacceptable and an average utility score of −105.98. As in the local energy study, participants showed a strong preference for *Switching any time*.

The second most important attribute was *Cost* with a score of 18.427, followed by *Billing structure*, *Percentage of energy from P2P*, and finally *Point of contact* scoring 12.934. 92 % of participants had *Saving money* in their winning tariff and 15.87 % marked a P2P tariff that *costs the same* as their current tariff as unacceptable. As predicted in H2, >95 % of alpha draws for *saving money* were higher than those for costing the same, with utility scores of 45.16 and − 45.16 respectively. In the *Billing* attribute, *One bill from the current supplier* was the most attractive attribute and *Two bills* was the least attractive.

In contrast to the local energy study, where the trend was for participants to want as much energy as possible from the local energy scheme, for the *Percentage of energy from P2P*, the most attractive level was *50 % of energy from P2P*, followed by *75 %*, with *25 %* in last place. *Current supplier* was the most attractive attribute level for *Point of contact*, with a utility score of 7.17. *Contact with both suppliers* was next and was chosen the most often in the ideal tariff (36.95 %). *Separate company* was the least attractive attribute level.

4.4.4. Smart home

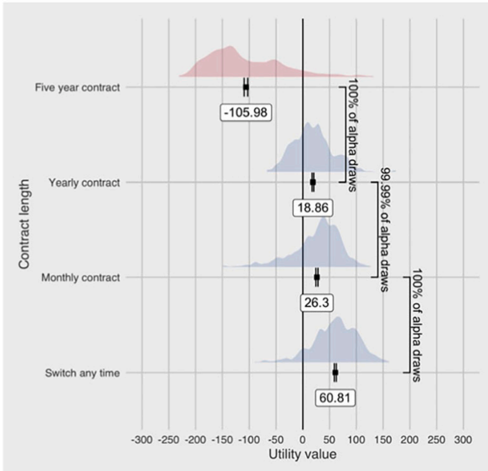
Table 5 and Figs. 10 and 11 present findings from the smart home study. Note that some attributes differ between the local energy and P2P studies and the smart home study, so results cannot be directly compared with the other studies. For each pair of attribute levels, at least 95 % of alpha draws were higher for the preferred level unless explicitly mentioned otherwise.

Contract length was the most important attribute, with an importance score of 45.25, followed by *Billing* with a score of 15.45, *Smart control*, *Point of contact*, and *Bundle* in last place with a score of 11.29. Switch any time was once again the most attractive attribute level with an average utility score of 69.21, and featuring in the ideal and winning tariffs for over half the sample. Five year contracts were highly unpopular, with a utility score of −134.51 and marked as unacceptable by 60.25 % of the sample.

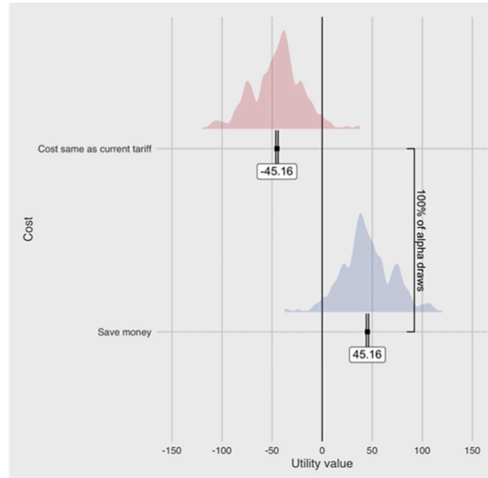
One bill from the current supplier had the highest utility score in the *Billing* attribute at 11.96. *Two bills* was chosen the most often in the ideal tariff (39.96 %), but had the lowest utility score of −10.03, indicating some polarisation. For *Smart control*, there was an overall preference for *No smart control*, with 11.07 % of participants marking *Smart control* as unacceptable and 67.65 % of winning tariffs featuring no smart control. However, this was more evenly split in the ideal tariff, with 54.30 % choosing to have no smart control in their ideal tariff and 45.70 %

[10] Selecting a feature in the ideal tariff is indicative of an initial preference for that feature, whereas a feature appearing in the winning tariff is indicative of that feature 'winning' in a trade off against other features. Marking an attribute level as unacceptable is indicative of a strong preference against this level.

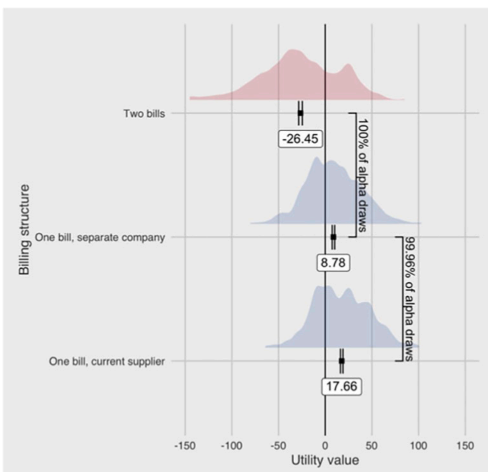
[11] As a Bayesian approach was taken in this study, frequentist tests for statistical significance were not applied. Instead, the 95 % confidence interval on each attribute level was determined by examining the last 10 k alpha draws (i.e. the estimated distribution of sample mean part-worth utilities at each draw of the HB model). Using the highest scoring attribute level as a reference point, if 95 % of alpha draws are higher than those of the next highest attribute level, we can be 95 % confident that this attribute level is preferred to the next best level [65]. For all studies, the 95 % confidence interval on alpha draws is presented in the results appendix.



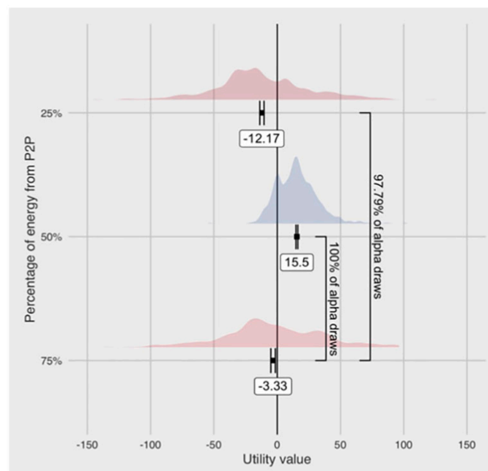
(a) Mean utility scores: contract length



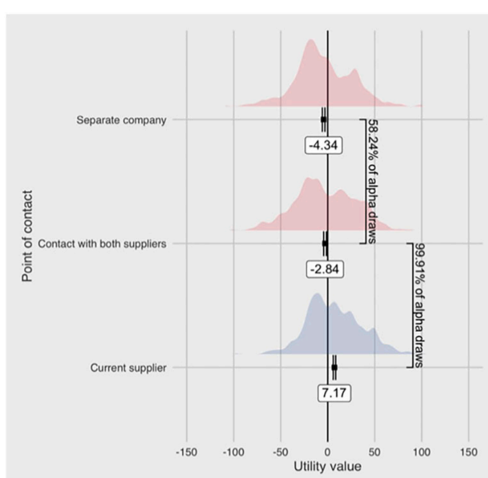
(b) Mean utility scores: cost



(c) Mean utility scores: billing structure



(d) Mean utility scores: percentage of energy from P2P net-work



(e) Mean utility scores: point of contact

Fig. 9. Sample mean utility scores for attribute levels in P2P study (mean for each level shown by a black square with error bars indicating the 95 % CI on the mean) and distribution of individual responses. The percentage of alpha draws that differ between pairs of attribute levels indicates the confidence level that there is a difference between these levels.

choosing *Smart control*.

A *Separate company* was the least attractive *Point of contact*; *Contact with both suppliers* had the highest utility score and was chosen in the ideal tariff by around half of the sample. 94.4 % of alpha draws for *Contact with both suppliers were higher than those for contact with the current supplier*. The most attractive *Bundle* was 6 months free use with a utility score of 13.19. The least popular bundle was the *Time of use discount*, with 94.6 % of draws lower than *Discounted electricity*.

Table 5
Smart home study: Percentage of participants with each attribute level in their ideal tariff and winning tariff, and percentage of participants marking each attribute level as unacceptable.

	Selected in ideal tariff (%)	Featured in winning tariff (%)	Unacceptable (%)
Billing			
One bill from current supplier	36.89	37.37	1.43
Two bills	39.96	34.29	6.76
One bill from separate company	23.16	28.34	3.89
Smart control			
Yes (i.e. supplier can control appliances)	45.70	32.44	11.07
No	54.30	67.56	0.41
Length of contract			
Switch any time	52.05	54.41	0.20
Monthly contract	14.14	20.74	3.07
Yearly contract	30.94	21.56	6.56
Five year contract	2.87	3.29	60.25
Point of contact			
Current supplier main point of contact	26.43	36.96	1.84
Separate company main point of contact	23.16	23.82	3.48
Contact with both suppliers	50.41	39.22	2.87
Bundle			
Discounted electricity for smart appliances	N/A	26.28	0.00
Six months free usage	N/A	43.53	0.20
Time of use discount	N/A	30.18	4.51

4.4.5. Electric vehicle study

Whilst the electric vehicle study shares analogous attributes with the smart home study, caution should be taken in drawing comparisons as this study was conducted on a sample of electric vehicle owners only, at a later date. Table 6 and Figs. 12 and 13 present results.

At least 95 % of alpha draws were higher for preferred levels than the next closest attribute level unless stated otherwise.

As in the other studies, *Contract length* was the most important attribute, with an importance score of 46.04. *Bundle* was in second place with a score of 14.98, followed by *Smart charging*, *Billing*, and finally *Point of contact* with a score of 12.28. *Five year contracts* were the least attractive, with a mean utility score of −129.7 and marked as unacceptable by over half the sample. Once again, *Switch any time* was the most popular level with a utility score of 76.8, featured in the winning tariff of 57.51 % participants and chosen in the ideal tariff of 54.08 % of participants.

The most popular bundle was the *Time of use super discount* and *Discounted electricity* was the least popular. For *Smart charging*, *No smart control* was more popular, appearing in 68.45 % of winning tariffs. However, in the ideal tariff, *Smart control* was chosen 49.57 % of participants, compared to 50.43 % for *No smart control*. *One bill from the current supplier* had the highest utility score in the *Billing* attribute, however, only 56.7 % of alpha draws were higher than those of the next highest level, *Two bills*. We can only be 56.7 % confident that there is a preference for One bill from the current supplier over *Two bills*. *One bill from a separate company* was the least popular, with a utility score of −6.97. For *Point of contact*, *Both suppliers* had the highest utility score, followed by the *Current supplier*, with the *Separate company* in last place.

4.5. Cross-study comparison

Fig. 14 summarises findings from the choice analysis.

Across all studies, *Contract length* was consistently the most important attribute. *Five year contracts* were unattractive and marked as unacceptable by at least half the sample in every study. Participants seemed to value the ability to *Switch any time*, which is surprising, given low levels of switching in the energy market [46]. This may be partially driven by the current energy crisis; several free text comments mentioned dislike of long contracts for fear of getting locked in at this volatile time. This is challenging from a business model development perspective, as many new energy business models requiring high capital investment by the service provider (such as heat-as-a-service) rely on long lock-in periods to be economically viable [11].

Point of contact was of low priority in all studies, with a mixture of

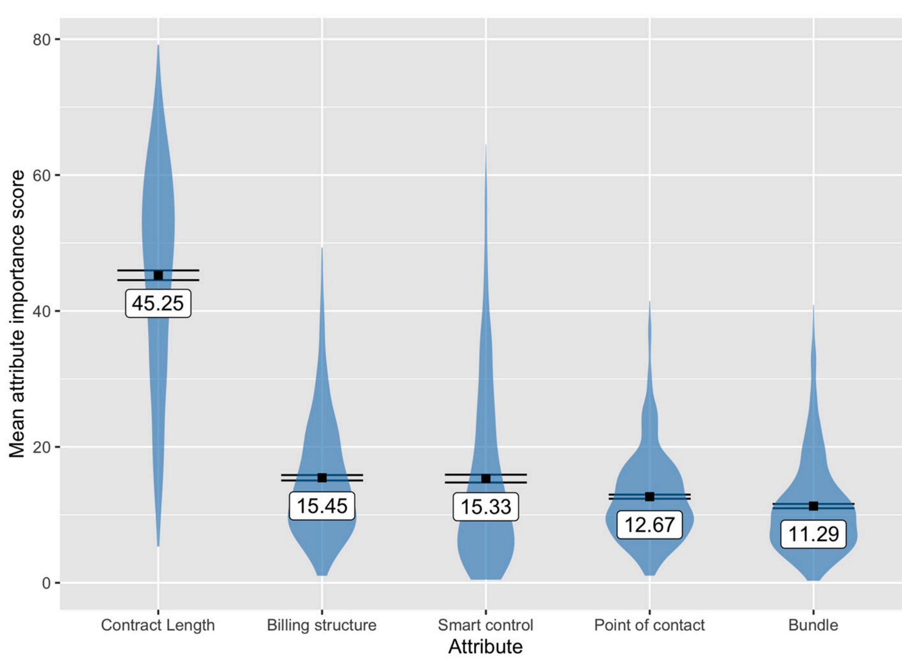
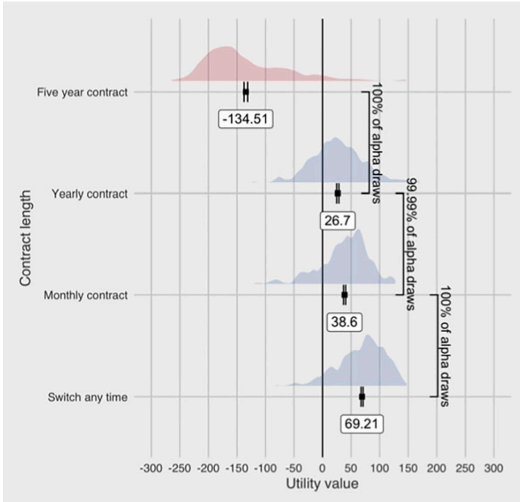
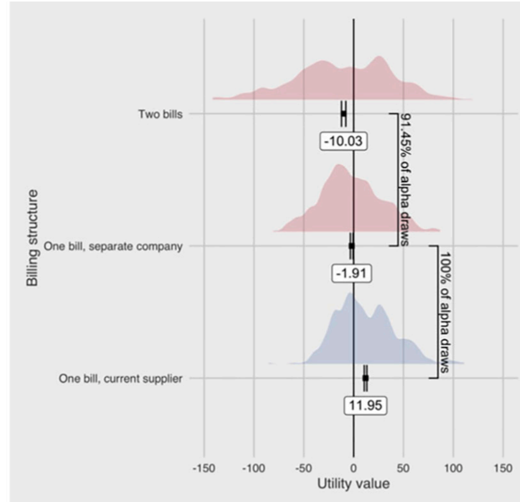


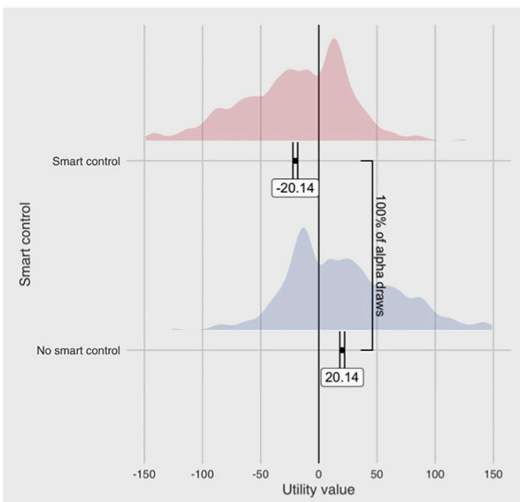
Fig. 10. Mean (indicated by a black square with 95 % CI) and distribution of importance scores for attributes in smart home study.



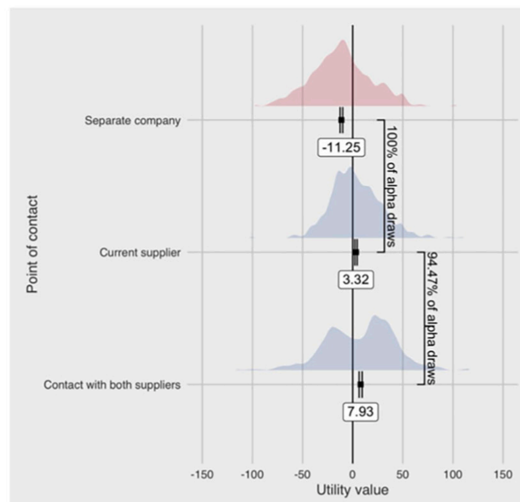
(a) Mean utility scores: contract length



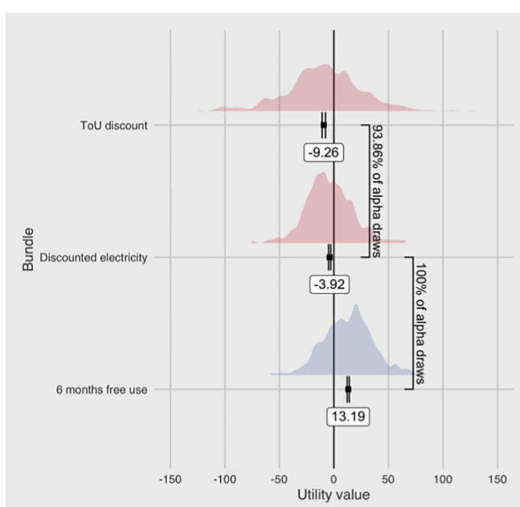
(b) Mean utility scores: billing structure



(c) Mean utility scores: smart control



(d) Mean utility scores: Point of contact



(e) Mean utility scores: Bundle

Fig. 11. Sample mean utility scores for attribute levels in Smart Home study. The percentage of alpha draws that differ between pairs of attribute levels indicates the confidence level that there is a difference between these levels.

Table 6
EV study: Percentage of participants with each attribute level in their ideal tariff and winning tariff, and percentage of participants marking each attribute level as unacceptable.

	Selected in ideal tariff (%)	Featured in winning tariff (%)	Unacceptable (%)
Billing			
One bill from current supplier	33.91	37.98	0.86
Two bills	48.50	37.55	3.00
One bill from separate company	17.60	24.46	3.22
Smart control			
Yes (i.e. supplier can control EV charging)	49.57	31.55	6.87
No	50.43	68.45	0.21
Length of contract			
Switch any time	54.08	57.51	1.07
Monthly contract	17.81	22.53	3.22
Yearly contract	25.32	15.45	8.80
Five year contract	2.79	4.51	54.94
Point of contact			
Current supplier main point of contact	23.61	34.12	0.43
Separate company main point of contact	14.59	21.67	3.22
Contact with both suppliers	61.80	44.21	2.15
Bundle			
Discounted electricity for charging	N/A	12.23	1.72
Free miles	N/A	37.55	1.50
Time of use discount	N/A	50.21	1.29

Contact with both suppliers and the *Current supplier* being the most attractive configurations. A *Separate company* managing the relationship between both suppliers was consistently the least attractive option across all studies. This suggests that business models involving intermediaries are unlikely to be attractive. Although the importance of *Billing* varied between studies, *One bill from the current supplier* was consistently the most popular attribute level. This indicates that, although there is high interest in the business models examined in this study, consumers were reluctant to accept the additional complexity of dealing with more than one bill and preferred an offering that mimics the experience they currently have with a single supplier. Constructing a multiple supplier offering primarily managed by the current supplier could be challenging; as noted in the CEPA Cost Benefit analysis [27], there is very little incentive for large suppliers to offer such services.

The main differences between findings from the Local Energy and P2P studies were in the importance of the *Percentage of energy from the secondary supplier*. This was much more important in the local energy study, ranking as the second most important attribute; in the P2P study it was the second least important. In the local energy study, participants tended to want as much energy as possible from the local energy supplier. By contrast, in the P2P study participants preferred to get just *50 %* of their energy from the P2P supplier. This is aligned with findings from Fell et al. [45], who found that when P2P was described as being offered at the neighbourhood level, participants were most likely to engage when 50 % of their energy use was met by the P2P scheme. This also reflects fears about the reliability of P2P expressed in the free text comments. As expected, tariffs featuring a cost saving were more popular in both studies, but cost was more important in the P2P study than the local energy study. This could be due to other perceived benefits from local energy, such as environmental and community driven factors, as mentioned in the free text comments and in line with findings from Adams et al. and Ford et al. [5,77].

In both the EV and smart home studies, *Smart control* (i.e. allowing suppliers to control energy assets for demand-side response) was generally perceived negatively. This contrasts with findings from Fell et al. [78], where direct load control was found to contribute towards the acceptability of ToU tariffs. However, almost half the EV sample chose *Smart charging* in their ideal tariff, suggesting that this attribute level was appealing for some EV owners. Notably, in the EV study, the *ToU super discount (highly discounted energy during off-peak times)* was the most popular bundle and the *Bundle* was the second most important attribute. This contrasts with the smart home study, where the *ToU super discount* was the most unattractive and the bundle was the least important attribute. This may be due to EV owners having increased

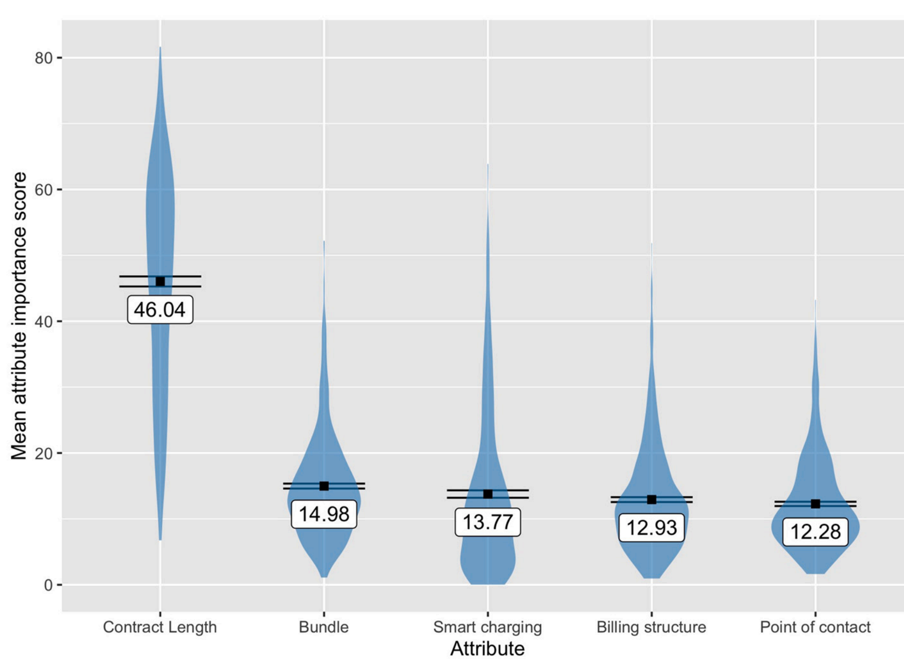
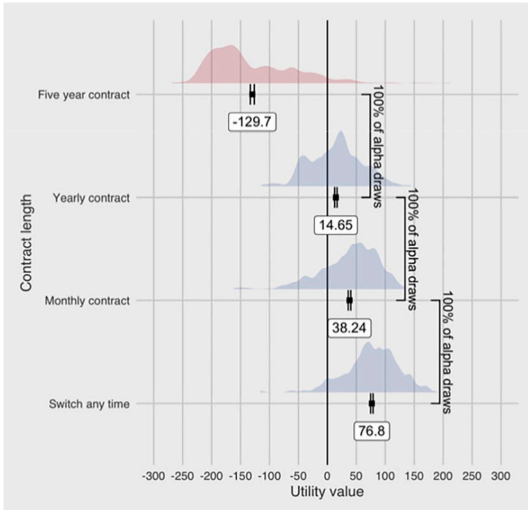
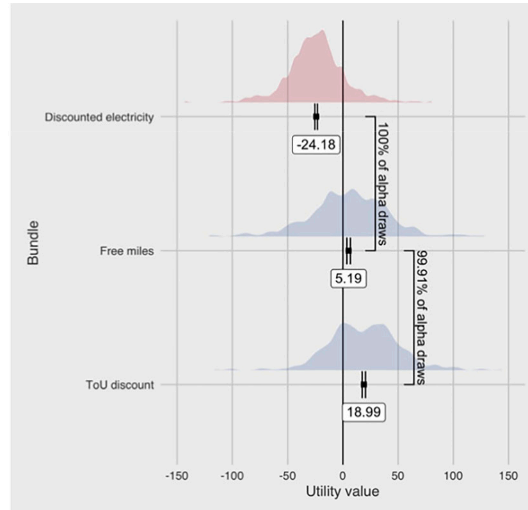


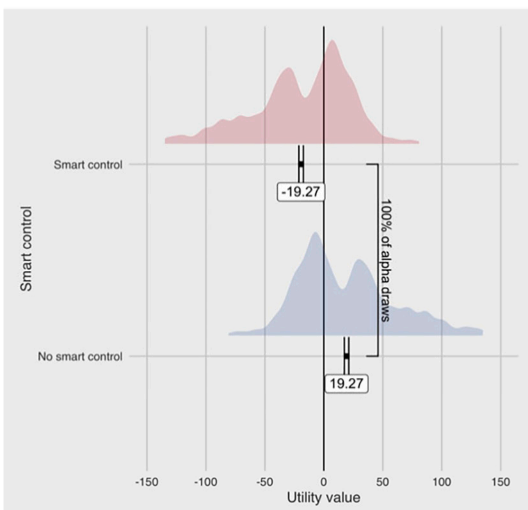
Fig. 12. Mean (indicated by a black square with 95 % CI) and distribution of importance scores for attributes in EV study.



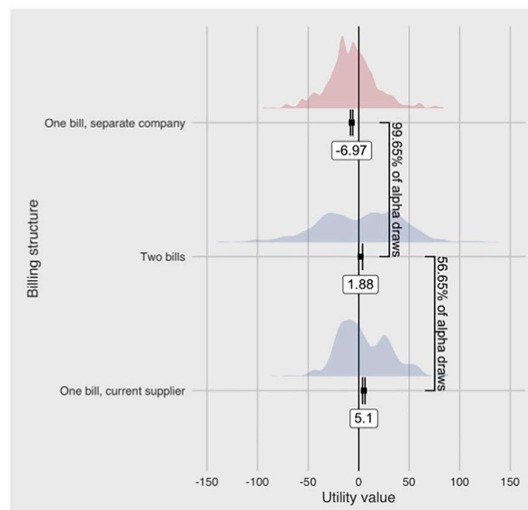
(a) Mean utility scores: contract length



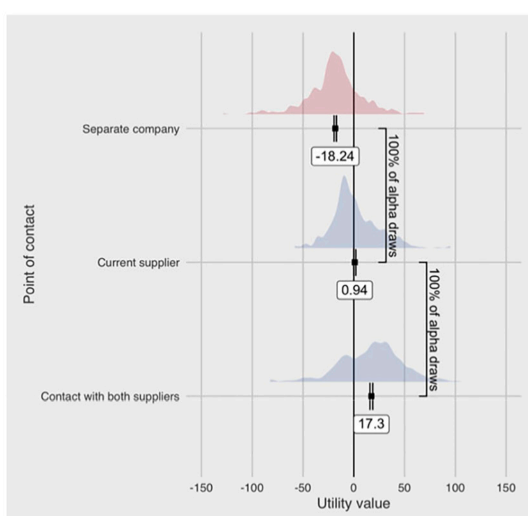
(b) Mean utility scores: bundle



(c) Mean utility scores: smart control



(d) Mean utility scores: Billing structure



(e) Mean utility scores: Point of contact

Fig. 13. Sample mean utility scores for attribute levels in EV study. The percentage of alpha draws that differ between pairs of attribute levels indicates the confidence level that there is a difference between these levels.

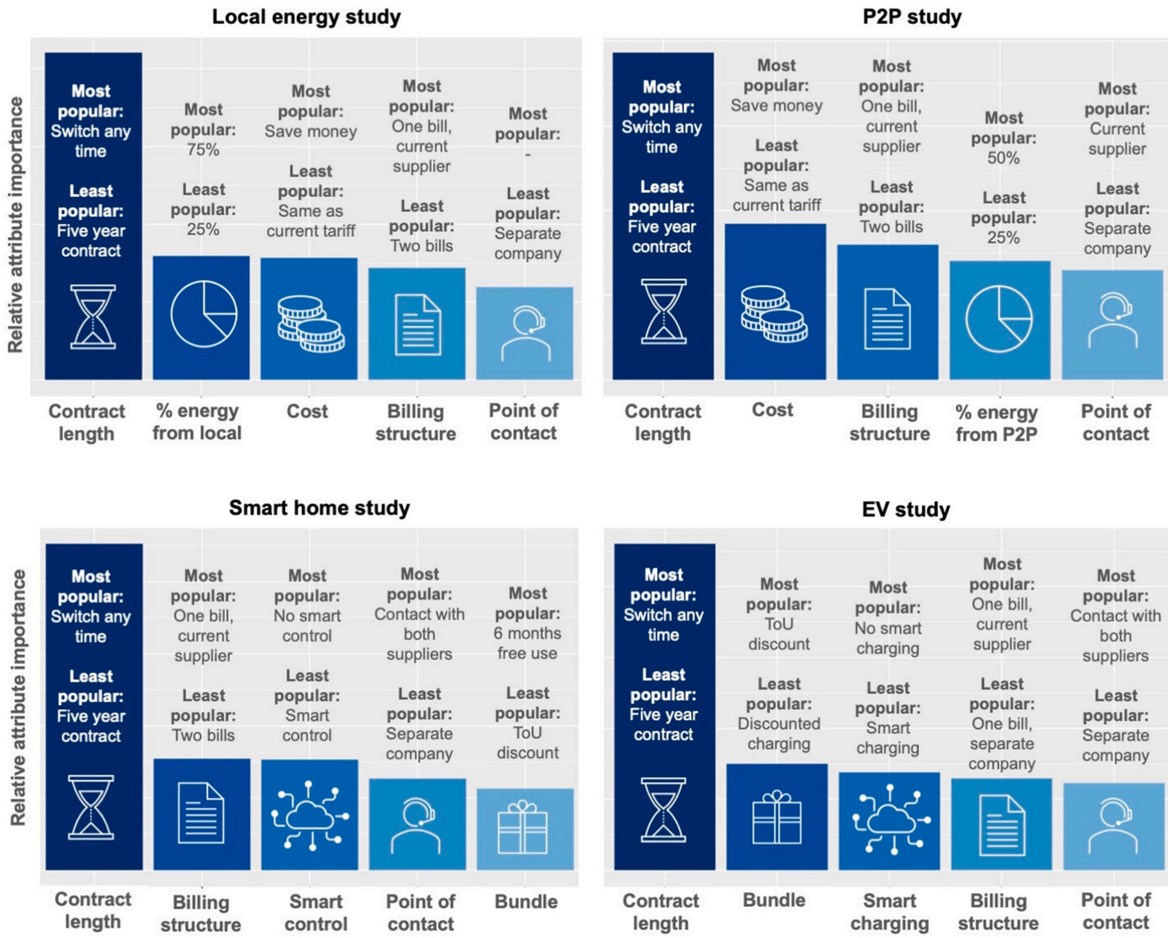


Fig. 14. Summary of attribute importance across all studies.

knowledge of ToU tariffs and their benefits, given the availability of ToU tariffs marketed specifically at EV owners [48,79].

4.6. Limitations

Further research with larger sample sizes could investigate the polarising nature of the smart control attribute among EV owners and understand which population segments this is most appealing to. Larger sample sizes and more detailed demographic and attitudinal information could also help build a more nuanced picture of the types of energy end users multiple suppliers are most attractive for. This is important for exploring equity outcomes from the availability of these models.

Another limitation is that preferences expressed in a survey experiment may not translate into choices made in reality [55]. The transaction costs of engaging are greatly reduced in a hypothetical environment and participants may have felt obliged to choose the multiple supplier option due to perceived social desirability bias or experimental demand effects. Similarly, as the decisions made were all hypothetical, participants may have been subject to hypothetical bias: it is well documented across multiple disciplinary applications of psychology that study participants tend to overstate hypothetical intentions and plans compared to real choices (see [80]). A fruitful avenue for future research could be to increase the transaction costs of expressing a preference for engaging, or to conduct research in a more realistic environment, for example by working with partners running pilot projects of these business models to access participants with 'real-world' experience, although this would come at the expense of nationally representative samples. It should also be noted that participants were asked about their likelihood of switching to their 'winning tariff' (i.e. their favourite configuration of attributes and levels) which they co-create through their completion of the survey. For this reason, the results cannot tell us how likely participants would be to switch to multiple supplier tariffs that were not their preferred configuration. A future study will explore this further by presenting a new sample of participants with a tariff that they do not design.

Another limitation was that in each of the studies, the multiple supplier model was presented to participants in the context of a use case it would enable. This was a practical decision as it allowed the concept to be described in a more tangible way. However, it makes it difficult to separate out interest in the use case itself from interest in multiple suppliers in general. Evidence from Watson et al. [28] suggested that people were more likely to engage with local energy in a multiple supplier model than if they had to switch entirely to a new local energy supplier. Survey experiments could be designed to explicitly test whether use cases such as P2P or specialised supply would be more attractive if offered with multiple suppliers or through e.g. a sleeving or white label arrangement by an existing supplier.

Finally, in all use cases, participants were told that they would either save money or have the same costs by engaging in these models, which may inflate acceptability. As current guidance on pre-commercial trials in the UK stipulates that trial participation must be non-punitive, this is realistic in the current regulatory context. Further research could investigate willingness to pay for these use cases.

5. Conclusion and policy implications

This study aimed to understand consumer attitudes towards purchasing electricity from multiple electricity suppliers, the acceptability of multiple supplier use cases, and the features of multiple supplier tariffs that are the most and least attractive.

With regards to RQ1a (How likely would participants be to engage with a multiple supplier tariff?), results indicated extremely high demand for local energy, P2P, and specialised supply for smart appliances and EV charging facilitated by multiple electricity suppliers, however this was conditional on the tariff design. >77.66 % of participants in all use cases answered that they would be at least 'somewhat likely' to switch to their 'winning' multiple supplier tariff if it were available to them in real life, and 44 % or higher in each use case stated they would be 'extremely likely' to switch.

Rising wholesale gas prices and geopolitical conflict are contributing to a volatile wholesale market and high energy prices across Europe [81]. Supporting innovative business models that facilitate low carbon supply, energy security, and demand reduction is more important than ever. However, there is a tension between opening up markets for new entrants and assuring consumer protection in case of their failure [74]. With the volatility of energy markets likely to continue over the next few years, there is a need to consider whether a market featuring multiple suppliers could be designed to insulate consumers from such shocks and support energy resilience. In the UK and EU, policy attention is turning to wholesale market reform and diversification of supply [82,83]. In the UK, this includes proposals for creating a separate market for renewables or 'green power pool' [84]. Supply localisation models supported by multiple suppliers, such as local energy and P2P, could feed into or work alongside such proposals.

In answer to RQ1b (How do recommendations from different entities affect the likelihood of engaging with multiple supplier tariffs?), engagement was consistently lower when the tariff was presented as a recommendation from a particular entity, with between 27.23 %–61.57 % of participants saying that they would engage in this circumstance, depending on the use case and the recommending entity. This is compared to 77.66 %–90.66 % with no recommendation. Recommendations from the local council (in the local energy and P2P studies only) and actors directly involved in delivering the multiple supplier model (i. e. the current supplier or the secondary supplier in partnership with the current supplier) had the most negative impacts on engagement. In all studies, recommendations from a friend or from the energy regulator had the least negative impacts. The negative effects of recommendations could be due to general distrust in the energy market during this turbulent time. Future research could investigate this finding further and explore potential solutions.

With regards to RQ2a (Which features of a multiple supplier model are most/least attractive to participants) and RQ2b (Which features of an interaction with multiple suppliers are most important to participants?) the choice analysis gave a strong indication that five year contracts would likely be highly unpopular. Contract length was consistently the most important attribute across all studies. This is challenging for business models that require longer term commitments, such as P2P models that need a stable community to be sustained in the long term or utility business models involving the installation of equipment, which need long term commitments from customers in order to be economically viable [1,11,18,85]. Companies reliant on longer term lock-in periods should consider how to incentivise participants to stay without requiring long contracts, for example through financial benefits for longterm customers, non-financial rewards and bonuses, or framing in terms of community or environmental responsibility [5]. A key question for further research will be establishing how the acceptability of longer contracts can be improved.

The most popular billing structure was consistently one bill from the current supplier, with a strong preference against involving third party intermediaries. This was also reflected in decisions made around the point of contact. This suggests that, although consumers desire the benefits and functionalities of use cases supported by having more than one supplier, they prefer not to engage with the additional complexity that entirely bilateral relations would necessitate and prefer market offerings akin to their current experiences with a single supplier. It has been suggested that a market role could develop for intermediaries to manage multi-party supply offerings (see [18]), however, the unpopularity of separate companies in this study imply that this is also unlikely to be appealing for consumers. The dislike of intermediaries to manage the relationships between multiple suppliers could be due to perceived increased transaction costs and complexity, or a distrust of third parties. This is challenging given that there is currently very little incentive for larger suppliers to take on the cost of billing to support secondary supply. A key point of contention in the debates around P379 was the requirement for the 'primary' supplier to continue to be responsible for metering and data collection/data aggregation activities, which was perceived as an unfair burden on the primary supplier (see responses to [86]) and discussion in [18]. Overall, these findings point to a tension between the market offerings most popular with consumers and the market offerings most favourable to the suppliers delivering them. One proposed answer to this dilemma is market competition; two experts interviewed by Watson et al. [18] argue that large suppliers unwilling to offer their consumers the opportunity to engage with multi-party offerings would lose out to suppliers who are. An alternative solution, as discussed during the P379 debates, would be mandating suppliers above a certain customer threshold to support multi-party supply, however this would likely be controversial to larger energy suppliers [22,27,86].

Finally, there were 46 comments in the free text box praising the ACBC survey as a useful and engaging way of choosing an energy tariff and for encouraging them to consider what they would want from an energy supplier. Designing surveys in the style of this study could be a tool for energy suppliers, comparison websites, and consumer advice centres to help customers choose a new energy tariff.

Although the modification to enable multiple suppliers in the UK has been withdrawn, the cost benefit analysis suggested that there would be value in reconsidering meter splitting, particularly in around five years' time when the impact of half-hourly market settlement and other electricity code changes [34–36,87] becomes clearer [27,33]. One challenge with assessing the costs and benefits of multiple suppliers was the high level of uncertainty regarding consumer uptake of multiple supplier offerings. If the case for multiple suppliers were to be revisited in the UK or elsewhere, findings from this paper contribute towards filling this gap and give empirical insight into the tariff configurations most likely to be acceptable. In the UK, legislating for multiple suppliers would require a mandate from the Department for Energy Security and Net Zero and approval from Ofgem. Overall, this paper has demonstrated high acceptability of the four use cases studied, but with caveats: findings indicate that consumers are averse to long contracts and would prefer their interactions to be managed through their current supplier. Future work will turn to examining a more realistic measure of uptake with higher transaction costs, as well as more detailed individual analysis to understand which population segments are most likely to participate.

CRediT authorship contribution statement

Nicole E. Watson: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Validation, Visualization, Writing – original draft. **Gesche M. Huebner:** Conceptualization, Methodology, Project administration, Supervision, Visualization, Writing – review & editing. **Michael J. Fell:** Conceptualization, Methodology, Project administration, Supervision, Visualization, Writing – review & editing. **David Shipworth:** Conceptualization, Funding acquisition, Methodology, Project administration, Supervision, Visualization, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data and R code is available for download from: https://dx.doi.org/10.17605/OSF.IO/NTGWK, under the Data and Code folder (DOI: 10.17605/OSF.IO/NTGWK).

Acknowledgements

We are grateful to eight expert interviewees for their invaluable insights, which informed the selection of use cases and attributes to test. We also thank Sawtooth Software Inc. for awarding Nicole Watson a student grant, enabling access to Sawtooth's software. We also thank three anonymous reviewers for their constructive and thoughtful comments.

Funding source

We gratefully acknowledge funding support as follows: UK Research and Innovation through the EPSRC Centre for Doctoral Training in Doctoral Training in Energy Demand (EP/L01517X/1); the Centre for Research into Energy Demand Solutions (EP/R 035288/1); and the Energy Revolution Research Consortium (EP/S031863/1). EPSRC, CREDS UK and EnergyRev had no involvement in the: study design; collection, analysis and interpretation of data; the writing of the report or the decision to submit this manuscript for publication.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.erss.2023.103403.

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