# Continuity and Disruption in UK Energy System Change: Mapping Expert Differences – and Understanding their Implications

Dr Michael Kattirtzi and Dr Mark Winskel, Science, Technology and Innovation Studies Group, University of Edinburgh, EH1 1LZ.
michael.kattirtzi@ed.ac.uk  mark.winskel@ed.ac.uk

## Abstract

Energy systems globally are undergoing dramatic changes, and many observers anticipate accelerated changes in the years ahead. The changes are being driven by a combination of high-level national and international policy agreements, as well as more bottom-up, insurgent changes in the cost and performance of energy technologies (supply, storage and use) and also changing consumer behaviours and social practices.

Less visibly, energy systems also exhibit strong elements of *continuity*, in terms of the renewal, extension and repurposing of existing technical infrastructures and institutions. This pattern of both disruptive and continuity-based change, which is particularly evident in the UK energy system, is reflected in energy experts' varied prescriptions for energy system change. As a result, there are multiple working definitions of the energy system change and system integration, with many questions and uncertainties about future pathways such as the extent of system rescaling, the key public and private agents of change and the extent to which consumers and citizens are likely to play a significant role in driving change.

In their review of energy scenarios, McDowall et al. (2014) noted the benefits of those studies which incorporated a diverse range of stakeholders and experts, and processes which were enable different views and evidence-bases to be articulated and confronted in a structured and constructive way.

Taking forward these recommendations, the UK Energy Research Centre (UKERC) has recently conducted a detailed survey of well over 100 UK energy stakeholders (researchers, policymakers, business leaders, advisory groups and others) aimed at mapping differences among energy researchers and stakeholders on the key strategic concerns for UK energy system development. The survey considered the changes facing the UK energy system over the next 20 years, including questions of governance and ownership, the role of citizens and consumers, possible energy system shocks and wider landscape pressures, and more specific patterns of continuity and disruption in heat, power and transport sectors. Survey respondents also had the opportunity to reflect on the fitness for purpose of UK energy policy and research.

Our paper and presentation will report the results of the survey with a particular focus on expert views about the role of citizens and consumers in the UK's energy system. The findings highlight a lack of consensus on the likelihood and desirability of disruptive or continuity-based changes across a wide range of policy and strategy issues, across many aspects of UK energy change, both in specific sectors such as power, heat and transport sectors, and the energy system as a whole. The results also suggest a perceived need for reaffirmed UK policy commitments energy demand reduction, and for greater public engagement at all levels.

# 1. Introduction

The theme for the 2018 BIEE Conference is "Consumers at the Heart of the System?". Forming the rationale for this theme, the conference organisers point out that many industry experts view "the changing role of the consumer in the energy system …[as] one of the big transitional issues of the coming decade". Quoting from the recent 'Reshaping Regulation', report by Challenging Ideas the authors explain that the conference intends to explore the implications of a shift to an energy system in which "connected consumers are key drivers, 'acting as the market makers rather than market takers of today'" (Sandys, Hardy, and Green 2017, 8, cited in BIEE 2018).

While there are signs of a dramatic reshaping of the UK energy system, there is also evidence of strong elements of continuity in terms of the renewal, extension and repurposing of existing technical infrastructures and institutions (Van der Vleuten and Högselius 2012; Winskel 2018)). Consumers might adopt new roles and drive change in the energy market, but they also have the power to make choices that reinforce elements of the energy market. Hence, with the conference theme in mind, (while also mindful of the need to adopt a 'symmetrical approach' to regime stability and change in exploring energy system transitions (Van der Vleuten and Högselius 2012), this paper aims to answer two questions on the basis of a recent survey of UK energy experts and stakeholders:

    i.  Do survey participants consider it likely that the role of citizens and consumers in the UK's energy system will change by 2040?

    ii.  Do survey participants deem it desirable for citizens and consumers to be more actively involved in the energy system by 2040?

The paper proceeds as follows. Section 2 outlines the research design adopted for the empirical survey. In section 3 we explore the empirical findings from the survey, starting with insights into the sample as a whole before considering how the substantive results address questions i) and ii) above. Section 4 provides the discussion and conclusion to the paper.

## 2. Research Design

The survey was funded by the UK Energy Research Centre (UKERC)[1] and took the form of a two-round Policy Delphi. It was conducted in Winter 2017/2018. The Policy Delphi method is designed for eliciting experts' views on complex policy problems where uncertainties, contingencies and multiple framings belie policy makers' efforts to make long-term decisions (de Loë et al. 2016). The aim of a Policy Delphi study is not to establish consensus, but rather to elicit the reasons why experts disagree in a given policy domain ((Turoff 2002, p.84), with a view to facilitate better informed policy debates. This is achieved by asking the same sample to take part in two or more rounds, offering participants a chance to respond to each other's arguments. In this way, policy Delphi is designed to 'reveal options and alternatives, points of agreement and disagreement, clarify arguments and uncover the strength of evidence associated with diverse viewpoints' (de Loë et al. 2016). Policy Delphi also offers an accessible method across disciplines, and is therefore well suited for a survey of the UK energy system's expert and stakeholder community. In recent years policy Delphi studies have been conducted on a wide range of contested policy topics, including tobacco policy in Kentucky, USA ((Hahn et al. 1999), the future of nanotechnology in the UK (Groves 2013) and resource allocation in the Irish health service (O'Loughlin and Kelly 2004). In each of these cases, the authors claim that the policy Delphi has made a positive contribution by identifying the key areas of disagreement and opportunities for collaboration.

To ensure that the survey captures as wide and varied array of expert views as possible, the sample for this study comprised of UKERC members, other academic researchers funded by the UK Research Councils to conduct energy research, and stakeholders including experts working in government / public bodies, industry, other business, and non-government organisations. The stakeholder list was developed with assistance from across the UKERC community, and expanded further through a snowballing technique (Bryman 2016).[2]

The topic statements were developed through an extensive period of desk-based research and collaboration between the authors, and refined through conversations with the project steering group, as well as a pilot phase with the UKERC community in summer 2017. Following Ian Miles and colleagues, and with a keen awareness of the diversity of our intended sample in terms of disciplines and professions, we developed topic statements that were as far as possible succinct, precise, unambiguous, devoid of confusing jargon or loaded terms, while at the same time being credible, inclusive and amenable to diverse responses (Miles, Saritas, and Sokolov 2016, p.102).

The questionnaire for this study is designed around two 'transition logics' for the UK energy system: continuity and disruption. Under a continuity-based transition, system transition is pursued mainly by adapting and repurposing existing organisations and infrastructures. New

---

[1] The UK Energy Research Centre (UKERC) carries out world-class research into sustainable future energy systems. UKERC acts a focal point for UK energy research and a gateway between the UK and the international energy research communities. Our interdisciplinary, whole systems research informs UK policy development and strategies of public, private and third sector organisations. UKERC is funded by the UK Research and Innovation Energy Programme (UKERC 2018).

[2] A study like this cannot be said to be truly 'representative' of the diverse UK energy research and stakeholder community, in that it is meaningless to claim that such a community could be objectively defined and sampled in appropriate proportions. However, in recognition of the diversity of actors and perspectives across the community, our ambition was to be as inclusive as possible in inviting participants to take part.

technologies, business models and behaviours are adopted, but as extensions and adaptions of existing ones. For the relatively highly centralised UK energy system, this would mean that economies of scale in generation and supply remain important. Smart technologies are introduced, but without fundamentally disrupting or rescaling system operation and ownership. Similarly, the system remains subject to a high degree of national strategic direction. Citizen engagement with governance processes is limited.

Alternatively, under a disruption-based transition, new technologies, business models and behaviours provoke a fundamental remaking of the UK energy system. Existing organisations and infrastructures are unable to respond sufficiently to the speed or scale of disruptive forces, and are destabilised and displaced. Digitisation and smaller scale generation and storage drive a rescaling and decentralisation of the system, both technically and institutionally, with regional and city/local authorities becoming key energy strategists. In this scenario, consumers might also be more influential in the energy system transition, for instance as prosumers or through active demand-side management becoming mainstream.

These logics broadly map on to the 'Two Degrees' and 'Community Renewables' scenarios in the National Grid's Future Energy Scenarios report (National Grid 2018). Both logics are consistent with the UK's climate change mitigation policy targets for 2050, but achieve them in considerably different ways.

In practice, the UK's actual energy system transition is likely to reflect both logics, with some infrastructure and organisations undergoing radical change while others adapt and renew to changing landscapes and niche developments. It is impossible to know how system dynamics will play out in the long-term. Nonetheless, it is important that a broad range of social and technical uncertainties are taken into account when policy-makers and stakeholders anticipate change, and that scenarios cultivate an informed understanding of the uncertainty space facing energy futures.

The survey structure explores UK energy experts' views on how these logics are likely to play out across a variety of topics: overall patterns of energy system change in the UK, future governance / policy, finance and ownership of energy assets, the role that citizens and consumers may play, system security and flexibility, how final energy demand is likely to change, landscape changes and system shocks and more sector-specific patterns of change and innovation in heating in buildings, power and transport. After a series of questions addressing the perceived *likelihood* of changes to the UK energy system, a later section invited respondents' views on their *preferred* policy and innovation priorities. In the final section of the survey, respondents were invited to assess the fitness for purpose of UK academic research on energy.

For each of the survey questions, we composed one-line statements relating to the possible character of the UK's energy system from the present to the year 2040.[3] Consistent with other Policy Delphi studies (de Loë 1995), participants were then asked to assess the statements on a 4-point Likert scale (in most cases ranging from 'Highly Likely' to 'Highly Unlikely'), with an additional option of 'undecided/cannot say'. Respondents were then asked to explain the reasoning behind their answer, with reference to any relevant evidence sources supporting it.

---

[3] The pilot survey included a number of different time periods related to different elements of the energy system. Pilot results suggested that respondents preferred a standard period. 2040 was chosen as the normal end-date for the survey questions, although for some questions (such as the impact of long term innovation) a longer time period was referenced.

In this way, the survey goes beyond measuring the diversity of expectations amongst respondents, by enabling investigation into the reasoning underlying these differences.

To answer the two questions set out in the introduction above, in this paper we focus on the participants' responses to the following sections of the survey:

1. Overall patterns of energy system change in the UK (section 3.2)
2. Citizen and consumer engagement (section 3.3)
3. Heating in Buildings (section 3.4)
4. Electricity Supply (section 3.5)
5. Personal Transport (section 3.6)
6. Preferred Means for Achieving Policy Outcomes (section 3.7)

The Round 1 surveys produced a wealth of empirical quantitative and qualitative data. For the quantitative Likert scale data, de Loë's (de Loë 1995, 62) consensus measure was used to assess the extent of consensus reached for each statement. For each statement, the degree of consensus is scored as either none, low, medium, or high, according to the distribution of responses across two valid contiguous categories (i.e. likely and highly likely; or unlikely and highly unlikely), as per Table 1 below. For example, a statement would have a 'high' consensus score if 80% of the valid answers are found in the 'highly likely' and 'likely' categories.

Table 1: De Loë's consensus measure

| Consensus measure | Minimum criterion for this consensus score in 2 categories |
|---|---|
| High | 80% |
| Medium | 70% |
| Low | 60% |
| None | <60% |

The qualitative data was analysed using NVivo 11 software. For each topic, comments were coded in terms of whether they supported the continuity or disruption scenario for that topic, or otherwise shed light on some relevant ambiguities and contingencies associated with it.

# 3. Survey Results

## 3.1. Survey Sample

A total of 129 participants took part in two parallel surveys. The first study was comprised entirely of UKERC members. Of the 159 UKERC members invited to form the first sample, 37 took part in Round 1, 22 of whom also took part in Round 2. For the sample comprised of the wider research and stakeholder community, we invited 427 non-UKERC researchers and other stakeholders to take part. 92 participated in Round 1, and 47 of these participants took part in Round 2. The sample sizes for these parallel studies are strong, and compare favourably against most academic Policy Delphi studies (de Loë et al., 2016). The first section of the survey asked participants to provide some background information about themselves, including their institutional affiliations, the sector they work in, self-declared disciplinary commitments and professional roles, and self-assessed levels of expertise on the topics explored in the survey. The results are summarised in Figures 1 to 3 below.

Figure 1 shows the range of disciplines that participants self-identified as belonging to. The results suggest a good spread of participants across natural sciences, engineering, economics and social science. Some of the most common self-declared disciplines participants added under the option of 'other' include: business, complexity science, energy modelling, interdisciplinary research, maths, and operational research, policy, statistics and technology assessment.
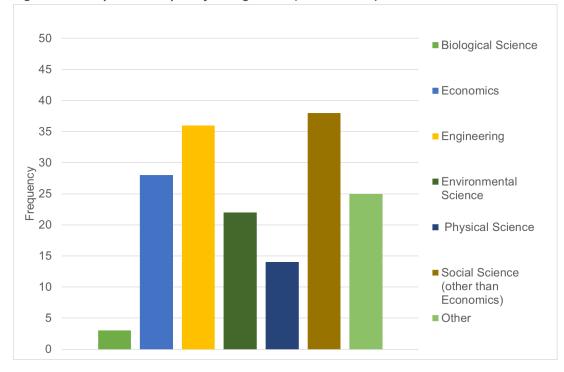
*Figure 1: Participants' Disciplinary Backgrounds (Self-Declared)*

*3.2. The Energy System Overall*

The first substantive section of the survey covered a series of 'whole system' issues, in terms of the broad patterns of UK energy system change up to 2040. The first question asked respondents whether they anticipated broadly disruptive or continuity-based changes to UK energy infrastructure and organisation over the next two decades. The results showed no measurable consensus: responses were approximately evenly divided between expectations of continuity-based and disruptive change, but with a small majority anticipating continuity-based change to be more likely (Figure 2 and Figure 3 below). We also found no statistically significant difference in the views of different types of respondent (researchers, business leaders, policy advisors and others).
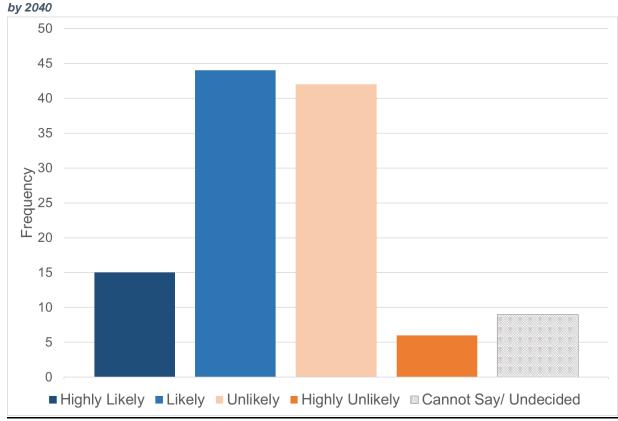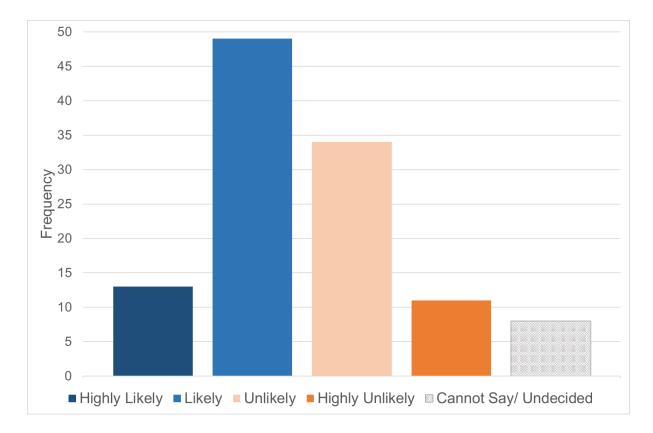
*Figure 2: Participants' Assessment of the Likelihood that the UK's Energy System Transition will be highly disruptive overall, with incumbent organisations and infrastructure largely replaced by radically new ones by 2040*



*Figure 3: Participants' Assessment of the Likelihood that the UK's Energy System Transition will be Continuity-Based Overall, with Incumbent Organisations and Infrastructure still Dominant in 2040*

Respondents' comments revealed that varied reasonings underlie diverging expectations about the broad pattern of energy system change. These differences covered both technological and social aspects, in terms of whether infrastructure developments were likely to involve adapting (rather than replacing) existing infrastructure, and whether incumbent organisations would be capable of successfully adapting to (or perhaps successfully resisting) the imperatives of a changing system.

Starting with the slight majority view, participants invoked a wide range of reasons for believing that overall the UK's energy system will undergo a continuity-based transition. These reasons include: the tendency of energy systems to change in mostly incremental ways given the technical and social interdependencies involved, the scale of investment required is believed to favour continuity-based approaches, incumbents are resilient and adapt to changing market dynamics, a lack of evidence of radical change to-date, and policy support and incentives is deemed to benefit the incumbents more than new entrants. Although the role of consumers was not discussed by most of the participants who anticipate continuity-based change, those who did discuss consumers tend to assume a passive role:

> "I'm cynical about how much politicians and citizens generally are prepared to engage in radical change."
>
> *A Senior Social Scientist at Cardiff University*

> "Policies are in place to support incremental shifts to a lower-carbon and more secure energy system, but I do not envision the political will, public pressure, or individual behaviour-change materialising that would prompt a paradigmatic shift in the way we (the UK) approach energy production and consumption."
>
> *A social scientist at Cardiff University*

> "Our work with customers and stakeholders, combined with our internal expertise, suggests we need gas and electricity for the foreseeable future, and there will be a need for transmission networks to 2050 and beyond. Making the best use of existing assets (rather than building new ones) will minimise the disruption caused and costs incurred."
>
> *A senior manager at a large energy networks company*

> "In terms of demand many policy initiatives are very conservative... they reproduce the status quo."
>
> *A senior social scientist at Lancaster University*

In contrast to this group, the future role of consumers in the energy system featured more prominently in the explanations given by those who believe that the system will experience disruptive-based change:

> "The energy system is going through a paradigm shift driven by a change in generation mix and consumer expectations. The incumbent players are responding to change at a glacial speed and will eventually be overtaken once market reforms allow real competition around flexibility."
>
> *The chief executive officer of a large energy efficiency firm*

> "Digitalisation, decentralisation and consumer-demand for novel energy services will disrupt incumbent organisations and infrastructures."
>
> *An academic social scientist*

> "The pace of innovation is quickening, and disruptive new technologies are emerging. Big data will mean that in 20 years' time peer-to-peer energy trading will be the norm, and self-consumption a reality (based on the falling costs of solar and storage). It is likely that households' demand for additional power will be much reduced."
>
> *A senior manager in a public body*

> "Will be much more consumer centric-with dominance of world class players like Amazon"
>
> *An advisor to the Welsh Government*

> "With increasing use of distributed renewable energy and energy storage, individual households and businesses are taking more interest in their energy use (and production), and tending to turn away from the larger suppliers."
>
> *A senior manager at an NGO*

Other reasons given by those who expect to see more disruption overall pointed to the novel network requirements of renewable energy generation and the vulnerability of incumbents to a wide range of technological, economic and political imperatives for change.

In Round 2, participants did not typically change their views, and the role of consumers was not discussed further. In response to the view that incumbents are adapting to a changing market, some participants argued that this is a new domain for them and so they will not necessarily maintain their dominance. Two participants did change their views: one conceded

that incumbent organisations may find it more challenging to adapt than they first believed, while another acknowledged the greater likelihood of continuity of transmission and distribution networks.

In summary then, just under half of the experts and stakeholders consulted in the survey expect the UK energy system to undergo disruptive changes overall by 2040, and many of these participants envision that consumers will adopt a more active role in the system. However, the slight majority of participants anticipate continuity-based changes by 2040, and these participants appear to assume that consumers will maintain a passive role.

### 3.3. Citizen and Consumer Engagement

Participants were asked to assess the likelihood that people will have a marked influence on the shaping of the energy system through citizen or consumer engagement by 2040. Figure 4 shows responses to the citizen and consumer engagement statements in Round 1. While there is a moderate level of agreement that citizens are unlikely or highly unlikely to have an impact through national level engagement (79% of valid answers), there is no consensus on the likelihood that citizens will have an impact through regional engagement processes. Greater consumer choice is seen by most participants as the means that is most likely to have a marked impact on the UK energy system by 2040 – there is weak consensus that this is likely or highly likely to happen (60% of valid responses).
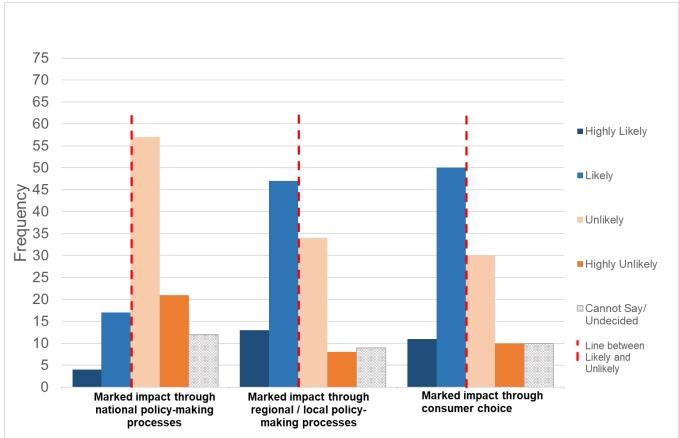
*Figure 4: Participants' Views on the Likely Impact of Citizen and Consumer Engagement on the Shaping of the UK's Energy System By 2040*

At the national (UK) level, many participants referenced current arrangements to argue that there is no tangible means for citizens to have an impact, with energy policy rarely featuring in public debates nationally:

> "Citizens in the UK have no direct say on the national energy policy making process. Everything is inferred by policymakers. I would say that citizens have a greater chance of influencing regional and local planning decisions although to say that they will have a marked impact on the shaping of the system depends on the extent to which local processes are important in future, which I think remains indeterminate."
>
> *A senior researcher at UCL*

> "Citizen involvement is conditioned by governmental will for stakeholder engagement. Nationally, this is limited."
>
> *A senior researcher at the University of Liverpool*

A few participants argued that citizens are, given that most are ill-informed to have an influence on national policy-making processes-. A minority pointed out that impact at a national level is sometimes achieved through citizen involvement at the regional or local levels.

Regarding the impact of consumer choice, the majority of participants envision citizens as a potentially disruptive force in the energy system, given their power to switch energy suppliers:

> "In terms of energy providers, consumer preferences are already having an impact, with large utilities increasingly switching towards a more services-based business model."
>
> *A researcher at the University of Cardiff*

> "We can already see evidence of increased engagement… As evidence I would put forward the fact that the big six energy firms lost 140,000 customers in the last year."
>
> *A Researcher at the University of Southampton*

> "I don't see that citizens are suddenly going to become actively engaged in decision processes, but I think there might be more switching etc. as people explore different offerings from those other than the Big 6."
>
> *A Researcher at the University of Leeds*

However, others expressed doubt that this mechanism would be used by a significant number of consumers, or that it will have a clear impact on the system:

> "I do not see a strong driver for significant behavioural changes in the consumer. Regulation and macro market forces are likely to limit the diversity of choice so in reality, consumers will not be able to make that much difference"
>
> *A Researcher at the University of Brighton*

> "The impact of citizen engagement tends to be overestimated by many in academia. Evidence about consumer switching to alternative suppliers is not encouraging from this perspective."
>
> *A senior researcher at the University of Bath*

It is clear that many participants' assessment of the likely impact of consumer engagement depends on the path the UK takes for energy infrastructure – in particular for heating services in buildings. Those who deem it most likely that a heterogeneous mix of infrastructure and technologies will emerge expect to see more opportunities for consumers to engage with the system – for instance as prosumers, community project stakeholders, and as participants in devolved processes. However, others expect people's ability to influence the system to be minimal, as long-term decisions are taken without their input.

One participant, who works at a large energy company, deems it unlikely that consumer choice will have a marked impact on the energy system, and warns that there are costs to expanding consumer choice in this way:

> "Whilst some citizens may opt for new technologies, this will usually be limited by high installation costs and ongoing running costs, as well as the housing stock, ownership and disruption involved. Grid defection could impact fuel poverty - decarbonisation of heat could create an extra 2.6m fuel poor consumers according to National Energy Action. In the absence of a national policy driving change in this area, nothing substantial will change for heat in the short term."
>
> *A senior manager at a large energy networks company*

There were mixed expectations expressed for citizen engagement at the regional and local level, with no consensus reached on this question. Some participants reasoned that this is likely to have an increased impact, as they observe a growing trend towards greater public participation in local and regional decision-making, while decisions about energy infrastructure are increasingly devolved:

> "[T]here are signs that local participation is increasing - e.g. local authorities' Sustainable Energy Action Plans, more participation in spatial planning and local budget decision making (participatory budgeting). I think as energy services become less homogeneous, citizens/consumers will seek a wider variety of packages from a wider range of supplier types, and that this will have a fundamental impact on the energy system by 2040."
>
> *A Research Associate at the University of Strathclyde*

> "As decisions become more focused on regional and local issues, the potential for citizens to influence this in particular directions is likely to increase."
>
> *A senior official at an independent public body*

> "[A]t a local level, decisions will be required on the means of providing decarbonised heat for example, as these will have strong local drivers. There is a requirement for good local strategic planning and this should inherently enable collaboration and consensus building."
>
> *A senior official at a government body*

> "There may be different solutions in different areas, e.g. heating choices, which will require active [citizen] engagement."
>
> *A senior executive at a public body*

Others remained sceptical of the idea that citizens will have an impact at the local or regional level, arguing that citizens trust local and regional authorities to make informed decisions:

> "I do not think that the overwhelming majority of citizens have engaged or will engage with energy policy or local planning. They will rightly expect their elected representatives to heed the voices of civil society, take an evidence-based approach and shape the energy system."
>
> *A Director at a public body*

> "It is a rare citizen who will be interested enough to want to contribute to shaping energy policy - most people want to flick a switch/tap and have the energy they require on demand. How it arrives and how it is planned for is largely out of their interest."
>
> *A Senior Lecturer at the University of Bradford*

Relatedly, one participant described the term 'citizen' as value-laden, and explained that people are highly unlikely to have an impact qua citizens because only a minority actively engage with energy issues in this way.

In Round 2, four out of 69 participants were persuaded that citizens are unlikely to have an impact at the national level, and seven reiterated this view, while three maintained that citizens do have an influence at that level. Another raised the concern that citizens' voices are often 'locked-in' through engagement processes, as a small set of actors' concerns can become reified and have long-term influence on the system.

Two participants expressed some concern about ill-informed citizens exerting too much influence at the regional or local levels, adding that citizen engagement is often reactionary with negative consequences rather than pro-active and positive in the UK. Last, one was persuaded that consumers are likely to have a greater impact on the system as electric vehicles and other new technologies that can empower them.

### 3.4. Heating in Buildings

In the previous section we reported that participants' views on the impact that consumers will have on the energy system depend on the participants' expectations for the future of the UK's energy infrastructure. This was particularly discussed in relation to heating in buildings, with those who believe that there will be a heterogeneous 'patchwork mix' of infrastructure and technologies also believing that consumers will adopt a more active role, while those who believe that national infrastructure will continue to dominate the provision of heating in buildings also claim that most consumers are likely to be more satisfied with the current situation and unlikely to want to change it.

Elsewhere in the survey, we asked participants to assess the likelihood that different models for the provision of heating in buildings will become dominant in 2040. As is clear in Figure 5, participants were somewhat divided on the most likely model. We found strong consensus that local/municipal/community based provision is unlikely/highly unlikely to be dominant by 2040 (85% of valid responses). 79% think that the patchwork mix model is likely/highly likely

to be dominant, yet we also found moderate consensus (72%) that the national infrastructure model is likely or highly likely to continue to be dominant in 2040. That many participants assessed both of these models as likely appears to reflect current uncertainties about the future of heating services in the UK, and also the perception that although significant change is likely in heating systems, it may be seen to a greater extent after 2040.
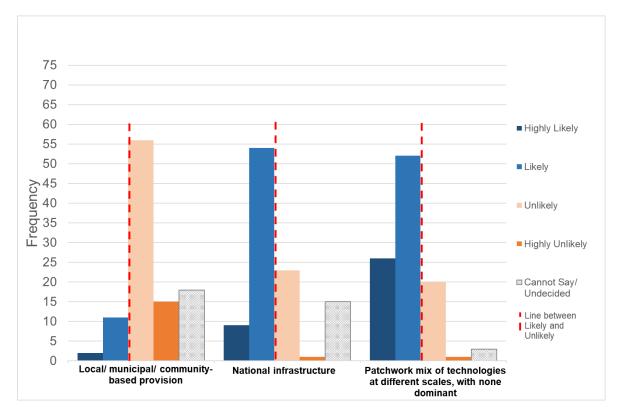
*Figure 5: Participants' Assessments of the Likelihood of Different Models of Heating Provision Being Dominant in the UK in 2040*



Participants generally explained their reasoning in terms of estimates of the relative costs of the different supply models, the system's capacity to change in the time period stated, and their view on the what the UK Government and other authorities are doing to support change. Amidst these arguments, however, there was a debate on whether consumers will drive change or adopt less engaged roles in the transition. Some of those who believe that a patchwork mix model will prevail in 2040 argued that different consumer preferences in different areas will be part of the driving force contributing to a patchwork mix of infrastructures:

> "The appropriate mix of technologies is not clear at the moment, but it is likely that a mix would be sensible from a 'top-down' central planner's perspective. Once you combine that with different preferences in particular parts of the country it is difficult to see a one-size-fits-all solution. Even if more expensive, it is likely that a more incremental approach based on existing networks is the most likely outcome in most places."
>
> *A senior analyst at a public sector body*

> "Due to geographic, demographic constraints (income levels, policy views) and the state of building stock, it is unlikely that one technology will dominate. this has also been recognised by the Energy Saving Trust."
>
> *A senior academic energy modelling researcher*

In contrast, those who believe that the continuation of national infrastructure is the most likely outcome claim that local heating networks will be less popular among consumers than national infrastructure:

> "Studies on UK district heating potential consistently ignore the fact that nobody gets rich selling district heating and there's no compelling consumer value proposition at the moment to switch from gas."
>
> *An academic energy modeller*

> "Public opposition to the disruption likely to be caused by moving to local heating solutions will slow down developments."
>
> *An economist at Imperial College London*

Another participant, who is ambivalent about whether national infrastructure or a patchwork mix will prevail in 2040, argued that heating networks are likely to grow in a patchy pattern across the UK, as support from consumers will not be universal:

> "I think local, municipal and community based heating will grow but remain niche as its growth will rely on rare enthusiasm and dedication and this sort of provision is highly disruptive in existing communities that don't already have the infrastructure."
>
> *A senior official in a public sector body*

In round 2 most participants did not change their view, but many were surprised by the results of round 1 – particularly that so many participants expect the national infrastructure to continue. Seven participants were persuaded that a shift to municipal, local and community-based heating provision is unlikely to occur by 2040, but only a couple of participants changed their answers for the other two propositions. Three responded by arguing that more evidence is required to clarify which is the best path for the UK.

In the next survey question we asked participants to identify the social and techonlogical innovations that are most likely to make the largest contributions to decarbonising heating services by 2040. Figure 6 provides a summary of the responses.
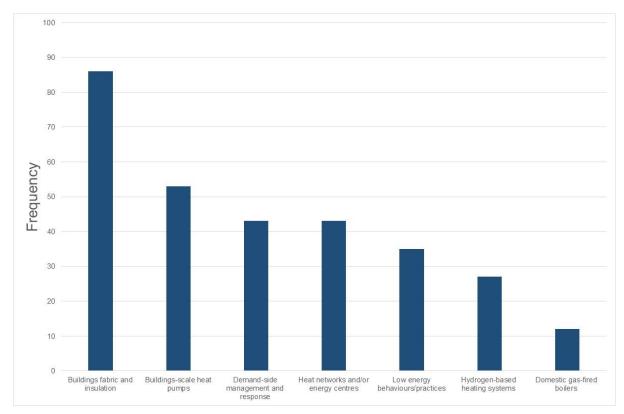
*Figure 6: Participants' assessment of the innovations that will make the largest contributions to decarbonising heating in buildings by 2040*



The results show a very high expectation that buildings fabric and insulation will make an important contribution, although the comments reveal that many participants' reasoning reflects technical potential policy targets, rather than evidence of actual progress towards attaining those targets:

> "Both the Scottish and UK governments are committed to substantial improvements to fabric/insulation and are developing policy to enable this and well insulated buildings are a necessary precursor to efficient functioning of heat pumps."
>
> *A senior manager at a large environmental NGO*

> "improvements in building fabric plus demand-side management seem obvious because they are low regrets options and can/ have potential to substantially reduce consumer bills."
>
> *An analyst at a public-funded environmental body*

Moreover, those who did not select improvements in building fabric and insulation raised concerns that the UK is not currently in a good position to achieve large-scale impacts in this way:

> "Improvements in buildings would probably be the most cost-effective solution and have very large impacts, but would require large socialised investment/ subsidies, and the development of a skilled work force. So unlikely in a climate of uncommitted policymaking."
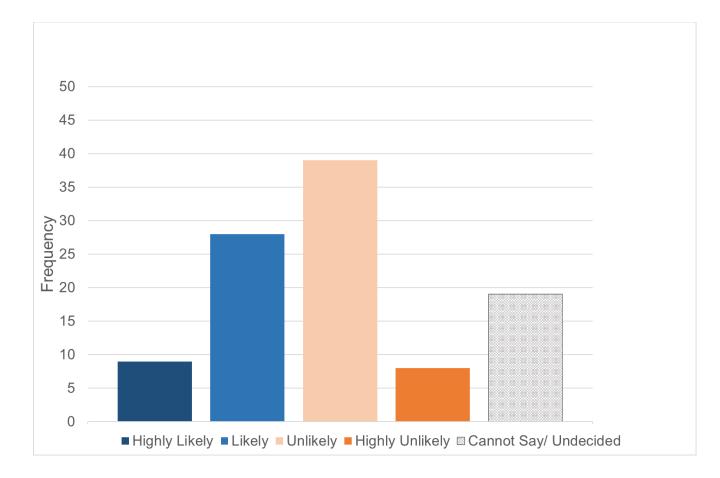>
> *A social scientist at Oxford University*

Hence, while many experts have high expectations that consumers (as home owners and tenants) will have a significant impact on the energy system through home improvements, it is not clear that this is feasible in practice. In a similar way, many participants identified demand-side management and response as a key innovation for decarbonising heating in buildings – especially if electrical sources of heating become dominant, but others urged caution, on the grounds that consumers' willingness to accept demand-side management and response in their homes is unknown. One participant argued that demand-side management response and home improvements could be made mandatory for all homes, but the majority of participants' comments assumed their success would depend on active engagement from consumers.

### 3.5. Electricity Supply

In the next section we asked participants to assess the likelihood that new intermediaries, aggregators and community energy companies will have largely replaced the dominance of large electricity suppliers by 2040. The results again reveal a lack of consensus around the logics of disruption and continuity-based change, but with a majority of respondents suggesting that incumbent replacement was unlikely or highly unlikely, as shown below in Figure 7.

*Figure 7: Participants' assessments of the likelihood that new intermediaries, aggregators and community energy companies will have largely replaced the dominance of large electricity suppliers by 2040*

Among respondents' comments, one of the key areas of disagreement concerns the likely extent of consumer support for alternative energy suppliers. Some participants consider it unlikely that a significant number of consumers will leave the large energy suppliers, given the lack of diversity in nature of the service, and the lack of any strong incentive to change supplier:

> "It seems likely that new entrants will come forward, but overcoming the market power of the incumbents will be hugely difficult, given the degree of homogeneity of delivered energy."
>
> *An economist at Imperial College London*

> "I really don't believe that the great British public care that much. I also think they just want this done for them. "Engagement" in energy is a nonsense."
>
> *An independent consultant*

On the other hand, some argue that consumers are already switching away from the Big 6 and this is only likely to continue as the sector becomes more heterogeneous:

> "Shift away from Big Six happening already. Aggregation of demand [is] likely to become more and more necessary at local level, then regionally and nationally. Unless large utilities can adopt the more flexible ways of new entrants they will continue to lose market shares."
>
> *A senior social scientist at the University of Oxford*

> "Real competition in electricity supply will occur over the next 2 decades as consumers begin to realise they can have energy tailored to their specific needs by smaller and bespoke energy companies"
>
> An economist at UCL

Intriguingly, price caps were invoked by those anticipating both disruptive and continuity-based change. On the one hand, they are seen as likely to homogenise the services from the perspective of consumers, but on the other hand they were seen as an instrument for disrupting the big energy suppliers' business models:

> "Unless the utility firms are forced to divest their retail businesses (i.e. customers), they will not be eclipsed because switching voluntarily will not happen at scale, especially after price caps are introduced."
>
> *A senior social scientist at the University of Oxford*

> "As soon as smart meters are prevalent, the value in the data will cause tech companies to flood into the market. The sticky customer pool will dwindle and become more of a hassle to the Big 6 as prices are capped. This process will be hastened by EVs - if Nissan's supplying my car then why not my house."
>
> *A generalist at a government body*

The other key area of disagreement that explains the responses in Figure 7 lies beyond the concerns here with citizen engagement, and concerns the viability (or otherwise) of large energy firms in the future electricity supply market.

In round 2, participants typically acknowledged counterarguments, but maintained their original view:

> "No change to previous answers although the comments from those who see change happening more rapidly make helpful comments. Most likely the utilities will adapt."
>
> *A senior natural scientist at a government body*

> "I can imagine aggregators will have some role, but not that they will have "largely replaced" the incumbents."
>
> *An academic engineering researcher at Newcastle University*

> "No change in response [highly likely]. Others answers probably too conditioned by strong current vested interests."
>
> *An advisor to the Welsh Government*

Next we asked participants which social and technological innovations are most likely to make the largest contribution to decarbonising the supply of electricity by 2040. The round 1 results are shown in Figure 8 below.
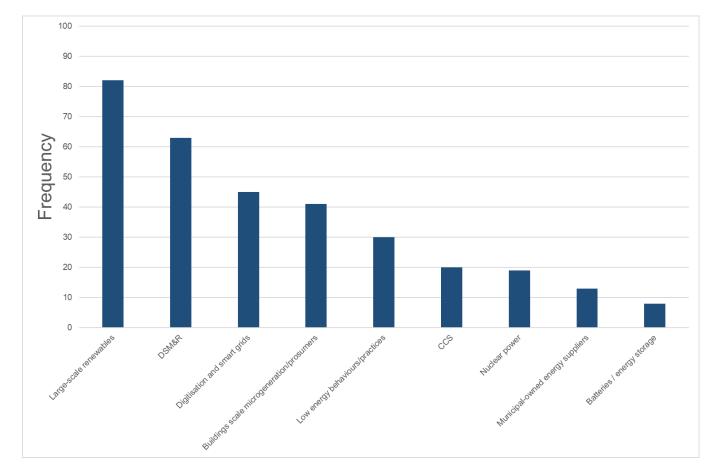
*Figure 8:Participants' assessments of the innovations that will make the largest contributions to decarbonising the UK's electricity system by 2040*



It is clear that large-scale renewables (along with demand-side management and response) were seen by the significant majority as the most likely innovations that will contribute to decarbonisation by 2040. The low for innovations that require greater consumer involvement may in part be due to a perception that do not always use low carbon energy sources:

> "Municipally-owner energy suppliers might be more prolific but they often have other goals aside from decarbonisation - they won't necessarily tackle this aspect."
>
> *An academic energy modeller at the University of East Anglia*

Nonetheless, it appears that the reduction in costs for renewables has led participants to select options which typically demand a less engaged role for consumers than other solutions, such as buildings scale microgeneration, low energy behaviours/ practices and municipal-owned supply.

> "Large scale renewables, and smart grids, are both areas that involve relatively few decision-makers - so I expect them to have significant carbon reduction impact. Demand-management and individual responses have huge potential but are likely to spread more slowly due to the inertia of so many millions of individuals and decisions required to make them happen."
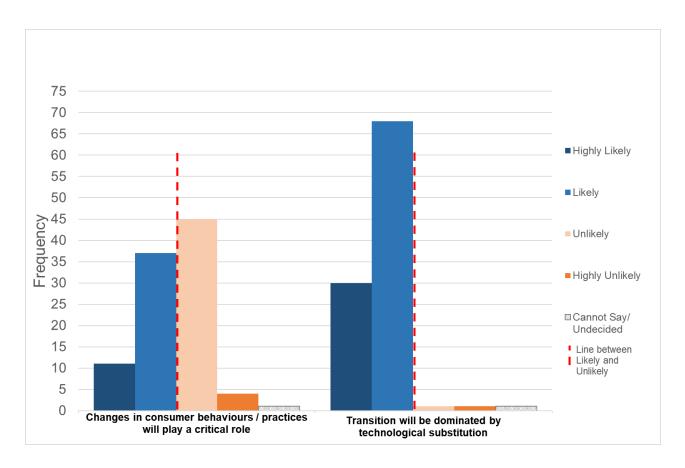>
> *An academic social scientist*

> "Scale economies drive almost all supply options as they always have done – big is better!... Building microgeneration is expensive because no scale economies."
>
> *An academic energy modelling researcher at UCL*

In round 2 eight participants changed their answers to now include demand-side management and response, but one expressed concern that the expectations associated with that are "overly ambitious".

### 3.6. Personal Transport

In the next section participants were asked for their views on the personal transport transition to 2040 (Figure 9). Strikingly, 98% of participants consider it likely or highly likely that the UK personal transport transition will be dominated by technological substitution. By contrast, the sample was roughly evenly split on the question of whether changes in consumer behaviours or practices will play a critical role in the transition.

*Figure 9: The Nature of the Transport Transition to 2040: "How likely or unlikely is it that the UK's transport transition will be shaped in the following ways?"*



On technological substitution, most comments made reference to the recent growth of electric vehicles and manufacturers' commitments to phasing out conventional vehicles:

> "Major European car manufacturers have now announced their intention to move away from internal combustion engines as a matter of corporate strategy"

*A UKERC-funded academic energy modelling researcher at UCL*

"There is a clear policy signal (banning petrol and diesel vehicles) and there has been a significant response from industry already around technological solution."
*A researcher in engineering at the University of Leeds*

"Electric cars are obviously on the way in."
*A natural science researcher at the University of Liverpool*

For some participants, technological substitution will open opportunities for changes in consumption patterns:

"The transition from internal combustion engines with ease of power, I.e. easily able to get petrol, to those that require electricity to charge, will change the paradigm of ownership. How people view transport will change as requirements changes, which in turn impacts energy demand."
*A Professor of engineering at the University of Liverpool*

[Technological] substitution will include low emissions vehicles, but from mid-2020's the autonomous vehicle will become an increasing % of new vehicle sales and redefine many aspects of transport and travel planning and behaviours. Changes in transport are likely to be much more about consumer behaviours and preferences than any other part of the energy system."
*A senior manager at a fuel trade body*

Other participants who think it is likely that consumer behaviours / practices will play a critical role in the transport transition typically extrapolated from marginal trends to all transport users:

"Millenials will come to adopt mobility as a service which will couple with the electrification/low emission/wireless charging to dominate"
*A Director at a Large Environmental NGO*

"Data on what's happening in London suggest that with consistently applied policies behaviour/practices do change and demand growth can be reversed."
*An Analyst at an Energy Consultancy*

In contrast, many participants expect such changes to have a relatively marginal impact overall:

"I think mode shift will be relatively small in importance, particularly outside London. Autonomous vehicles & car sharing may keep people in cars and directly compete with mode-shifting options."
*An academic energy modelling researcher at UCL*

"Changes in consumer practice may be important in cities where other options are viable, but elsewhere will only play a small role. Technology change is therefore likely to dominate in the 2020s and 2030s."
*A senior academic engineer at the University of Leeds*

In round 2 only three participants were persuaded to change their views on the role of the consumer: A Professor of Engineering and a civil servant were both persuaded that the younger generation are likely to have an impact on the system by 2040 by shifting away from vehicle ownership. Another respondent changed their mind on the grounds that what consumers do is influenced by the technologies they use and vice-versa:

> "As behaviour and technology are so closely linked (energy systems and their elements being socio-technical in nature, etc.) I don't find them easy to disentangle. Hence I've now shifted to 'likely' for both."
>
> *A social scientist at UCL*

Two other participants repeated the argument that modal shift is only likely to have an impact in urban areas, and a few added a call for government policy to encourage greater change in consumer behaviours and practices, on the grounds that such a change is unlikely to occur without it.

Last, a different social scientist responded to the high expectations for electric vehicles with some caution:

> "I can see my views are in a minority on this topic. I know less about transport than other areas in the survey, perhaps that is why. It may also be recent experience of considering buying an electric car, and finding it impractical on technology, cost, charging ability, car choice etc. grounds. The low emission vehicle future doesn't seem all that near to me!"
>
> *A social scientist at Oxford University*

Turning to the social and technological innovations for decarbonising personal transport by 2040 (Figure 10), participants' assessments are broadly consistent with the findings shown in Figure 10 above, with electric vehicles and hybrid electric vehicle expected to make the largest contribution.
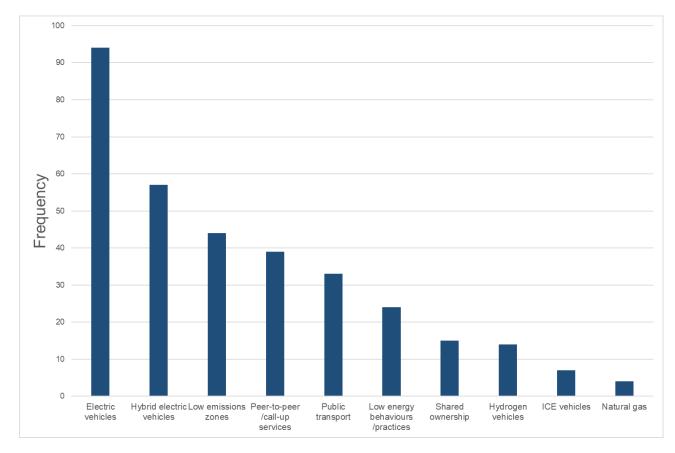
Low emission zones were seen by many participants as playing an important role in urban areas, but with limited impact on decarbonisation overall for the UK. The expectation that modal shift will remain marginal in many areas was explained by some respondents in terms of unappealing public transport services:

> "Electric vehicles (all forms are happening). The outlook for public transport does not seem good … Whilst there have been some good developments in public transport the overall picture is bleak."
>
> *An engineering researcher at the University of Cambridge*

> "The failure of government to back [rail] upgrade[s] … demonstrates why this will be so difficult to achieve."
>
> *A researcher at the University of Durham*

Last, some participants pointed out that shared ownership, peer-to-peer services and autonomous vehicles could all lead to *increased* use of transport services, and so will not necessarily contribute to decarbonisation.

In round 2, six participants added hybrid electric vehicles – one of whom also removed fully electric vehicles:

> "Since filling out the first survey, my colleague has started analysing data from public attitudes surveys about electric vehicles, and consumers absolutely hate them!

There is a severe acceptability gap for EVs; however, this is less the case for hybrids, therefore I think uptake of these will be higher."

*A social scientist at the University of Sussex*

### *3.7. Means for Achieving Energy Policy Priorities*

At the end of the survey participants were asked what the UK Government *should do* to achieve energy policy goals, rather than the preceding assessments of likelihood. Table 2 below presents participants' views on propositions relating to the role of citizens or consumers in the energy system.

The overwhelming majority of participants agree or strongly agree that energy demand reduction should be an energy policy priority. The table also reveals high levels of support for instruments that facilitate greater citizen involvement (at all levels) and consumer choice. All such instruments score higher than regulating energy prices and price caps, which, as we saw in section 3.5, are seen by some as likely to reduce consumer choice.

*Table 2: Participants' Views on what the UK Government 'Should Do'*

| UK Government should… | Percentage of participants who agree/ strongly agree | Valid total |
|---|---|---|
| ...establish energy demand reduction as an energy policy priority | 92% | 101 |
| ...support greater citizen involvement in regional and local planning for energy projects | 87% | 89 |
| ...facilitate a devolved approach to energy system change to emerge, with support focused on early pilot studies | 81% | 85 |
| ...assist new entrants in the market, including peer-to-peer trading and new aggregators | 81% | 84 |
| ...seek to empower consumers over the choice of provider, fuel type and origin | 81% | 94 |
| ...support greater citizen involvement in national energy policy decision-making | 75% | 89 |
| ...take over ownership of energy infrastructure and organisations | 38% | 76 |
| ...regulate energy prices and / or consider introducing price caps | 35% | 82 |

Despite eliciting a high degree of support, only a couple of comments were made about establishing energy demand reduction as a priority. These participants emphasised that it is an important, low regrets step for decarbonisation – echoing the findings above that

improvements in building fabric are expected by most participants to make one of the largest contributions to decarbonising heating in buildings (Figure 6 above).

There was greater discussion about engaging citizens at the regional level, with some claiming this would be an easy and useful step for securing buy-in for the low carbon transition. One also argued that citizen engagement could substantially improve policies, by placing an emphasis on wellbeing. Yet, this view was contested by another who is concerned the process would be co-opted by a vocal minority.

Comparing these results against those who believe it is likely that citizens will have a marked impact at a regional or local level (Figure 4 above), it is clear that nearly all participants consider it important that citizens are engaged at a regional and local level (87% of valid responses), while less than half consider this likely (41% of valid responses). This suggests that a significant proportion of the participants would like to see more policy support in this area.

Government ownership (38% agree or strongly agree) and price regulations or caps (35% agree or strongly agree) are much more contested propositions:

> "Government is not good at picking winners - either technologies or market participants."
>
> *An independent industry consultant*

> "A price cap would be a disaster, reinforcing Big 6 and putting new suppliers out of business."
>
> *A senior researcher in natural science at Imperial College London*

One dissenting voice argued that since most consumers have not changed supplier since liberalisation occurred, consumers are likely to be exploited without further government intervention.

## 4. Discussion and Conclusions

As set out in the introduction, the aim of this paper is to address the theme of the BIEE 2018 conference by using recent researcher and stakeholder survey results to answer the following two questions:

i. Do survey participants consider it likely that the role of citizens and consumers in the UK's energy system will change by 2040?

ii. Do survey participants deem it desirable for citizens and consumers to be more actively involved in the energy system by 2040?

In regard to the first of these questions, the survey results summarised in section 0 portray a mixed view. We found that a small majority of participants anticipate continuity-based change in the UK's energy system overall by 2040, and these participants appear to assume that this will involve consumers continuing to play a largely passive role in the energy system. On the other hand, the view that consumers' expectations are changing and will become a driving force for radical change in the UK's energy system before 2040 is one of the most prominent reasons given by the slight minority of participants who expect to see more disruption-based change.

In section 3.3, we reported weak consensus that consumer choice is likely to have a significant impact on the UK energy transition. A key point of disagreement between respondents here is whether consumer switching is already happening at a high enough rate to make substantive impact by 2040. Probing further, we found that many participants' expectations about the impact of the consumer choice depends on whether infrastructure and technologies are likely to be disrupted or not – there is no easy separation between the social and technical aspects of change. This was particularly discussed in relation to heating in buildings, where those who believe the transition is likely to be disruptive (in the form of local energy network solutions and heat pumps) are also more likely to expect that consumers will take a more active role.

Section 3.4 did not reach consensus on this issue either – participants were torn between the likelihood of a disruption-based transition in heating services and a continuity-based transition in which the natural gas network will continue to dominate 2040, albeit with some repurposing. While those (in the minority) who think a disruption-based logic is likely to dominate for heating services believe this is likely to be driven by more actively engaged consumers, the greater number of respondents anticipate continuity-based changes and tend to believe that most consumers will remain passive, and many may even resist disruptive changes. Also in section 3.4, we reported that a clear majority of participants expressed high expectations for the improvement of buildings fabric and insulation – something likely to require a significant role for homeowners and tenants – but doubts were raised about the feasibility of this given an apparent lack of policy support.

Regarding consumers' role in shaping the supply of electricity in the UK by 2040, the likelihood of consumer buy-in was a key point of disagreement between those in the majority who believe that large energy suppliers will continue to dominate the market and those in the minority who believe that they will be overtaken by new entrants and alternative business models. Buildings scale microgeneration and municipal-owned energy suppliers scored low in

the respondents' assessment of the innovations that are most likely to make the most important contributions to decarbonising the electricity system by 2040. Large scale renewables were seen as the clear 'winner' here for most participants.

A greater level of consensus was found in the questions on personal transport, where most participants expect the role of consumers to be broadly similar with their roles today. Technological substitution – in the form of electric vehicles and hybrid electric vehicles – were considered by the vast majority of participants to dominate the transition for personal transport. Modal shift, behaviour change and changes in consumer practices are expected by less than half the participants to play a critical role in this transition – and some thought they could lead to increases rather than decreases in carbon emissions.

Finally, the results reveal that most respondents believe the UK Government should encourage people to play a more active role in the energy. We found strong agreement that Government should do this by establishing energy demand reduction as a national policy priority, encouraging citizens' involvement in national and regional policy-making, expanding the range of options available to consumers, and empowering consumers to make choices over their energy provider, fuel type and origin. This suggests a significant gulf between expectations of likelihood and desirability on the role of citizens. Given this gulf, the results imply the need for caution in casting consumers at the heart of the UK's future energy system. While there are increasing possibilities and preferences for the repositioning of consumers from the margins to the centre of the UK energy transition, many doubt this will occur in practice.

## 5. References

BIEE. 2018. "Conference Theme | BIEE." http://www.biee.org/conference-list/consumers-heart-energy-system/conference-themes-2018/ (August 30, 2018).

Bryman, Alan. 2016. *Social Research Methods*. 5th ed. Oxford: Oxford University Press.

Groves, Christopher. 2013. "Four Scenarios for Nanotechnologies in the UK, 2011–2020." *Technology Analysis & Strategic Management* 25(5): 507–26.

Hahn, Ellen J, Christopher P Toumey, Mary Kay Rayens, and Carrie A McCoy. 1999. "Kentucky Legislators' Views on Tobacco Policy." *American Journal of Preventive Medicine* 16(2): 81–88.

de Loë, Rob C. 1995. "Exploring Complex Policy Questions Using the Policy Delphi: A Multi-Round, Interactive Survey Method." *Applied Geography* 15(1): 53–68.

de Loë, Rob C., Natalya Melnychuk, Dan Murray, and Ryan Plummer. 2016. "Advancing the State of Policy Delphi Practice: A Systematic Review Evaluating Methodological Evolution, Innovation, and Opportunities." *Technological Forecasting and Social Change* 104: 78–88.

McDowall, Will, Evelina Trutnevyte, Julia Tomei, and Ilkka Keppo. 2014. *UKERC Energy Systems Theme: Reflecting on Scenarios*.

Miles, Ian, Ozcan Saritas, and Alexander Sokolov. 2016. "Intelligence: Delphi." In *Foresight for Science, Technology and Innovation*, Heidelberg: Springer International Publishing, 95–124.

National Grid. 2018. *Future Energy Scenarios 2018*. Warwick.

O'Loughlin, Rosalyn, and Alan Kelly. 2004. "Equity in Resource Allocation in the Irish Health Service: A Policy Delphi Study." *Health Policy* 67(3): 271–80.

Sandys, Laura, Jeff Hardy, and Richard Green. 2017. *Reshaping Regulation*.

Turoff, Murray. 2002. "The Policy Delphi." In *The Delphi Method: Techniques and Applications*, eds. Harold A. Linstone and Murray Turoff. , 84–101.

UKERC. 2018. "About Us." *About US*. http://www.ukerc.ac.uk/about-us.html (August 31, 2018).

Van der Vleuten, Erik, and Per Högselius. 2012. "Resisting Change? : The Transnational Dynamics of European Energy Regimes." In *Governing the Energy Transition: Reality, Illusion or Necessity?*, eds. G. Verbon and D. Loorbach. London: Routledge, 75–100.

Winskel, Mark. 2018. "Beyond the Disruption Narrative: Varieties and Ambiguities of Energy System Change." *Energy Research & Social Science* 37: 232–37.