Continuity and Disruption in UK Energy System Transition: Evidence from a survey of energy experts

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Introduction

Energy systems globally are undergoing dramatic changes, and many observers anticipate accelerated changes in the years ahead (e.g. PwC, 2016; Energy Institute, 2017; Wilson, 2018). The changes are being driven by a combination of high-level national and international policy agreements and targets (especially the 2016 Paris Agreement on climate change) and 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, however, energy systems also exhibit strong elements of continuity, in terms of the renewal, extension and repurposing of existing technical infrastructures and institutions (van de Vleuten and Högselius, 2012; Winskel, 2018a).

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 is considerable 'interpretive flexibility' over the UK's energy system transition (Bijker and Pinch, 1984), with different working definitions of system boundaries and system integration, deep uncertainty over issues such as the extent of system rescaling, the key public and private agents involved, and the extent to which consumers and citizens are likely to play a significant role.

In the UK, for example, there is developing interest in prospects for repurposing existing assets and organisations, while calls by some for radical changes in asset ownership are countered by more modest calls for improved market regulation. Amidst such uncertainty about the UK's energy system transition pathway, system operators, energy suppliers, governing authorities – and energy observers and researchers – need to make long-term commitments in light of the best available evidence. Energy scenarios can play an important role in this context – not as predictors of the future, but as tools to broadly describe the uncertain space within which actual futures are likely to develop (Eyre and Baruah, 2014). Of course, energy scenarios themselves can only be as impartial, robust and credible as the expertise on which they are based.

While it would be naïve to expect energy scenarios to achieve consensus amongst experts, recent studies have highlighted weaknesses and disciplinary blind-spots associated with conventional approaches to energy scenario formation (Pye and Li, 2018; Li, 2016). In particular, system actors' diverse perspectives and activities are often reduced to assumptions that they act in a cost-driven, 'utility-maximising' fashion which is not always reflected in practice. Moreover, small variations in these assumptions can lead to a diverse range of solutions, and yet influential investment decision-making factors that cannot easily be summarised in numerical parameters (such as trust in institutions and processes) are left out of models.

Li and Pye argue that energy experts must "escape from caged thinking concerning what can or cannot be included in models and therefore what types of uncertainties can or cannot be explored" (2018, p.130). Li and Pye also call for greater integration of qualitative narratives with quantitative analysis. Similarly, a review of energy scenarios (McDowall et al., 2014) highlighted the dangers of cognitive biases such as confirmation bias and availability heuristics. The study suggested the value of incorporating a diverse range of views and experts, and of counterpose contrasting views and evidence-based claims in a structured way, when developing future energy scenarios.

These issues can be viewed as a consequence of experts working in relatively narrow disciplinary paradigms, and often on isolated components of the energy system. The actual practice of combining together different disciplines and bodies of expertise is fraught with difficulty (Sarewitz, 2010; Jacobs, 2013), and is unlikely to result in consensus (Stirling, 2008). Nonetheless, by bringing together different disciplinary perspectives, focusing on the whole energy system (Winskel, 2018) and facilitating dialogue among experts, learning can be achieved (Rip, 2003, p.425).

As well as a commitment to interdisciplinarity and holism, others suggest the need for a 'symmetrical approach' to regime stability and change in exploring energy system transitions (van de Vleuten and Högselius, 2012). While early research on sustainable transitions viewed niche innovations outside of the regime as key drivers (as highlighted by Berkhout, Smith and Stirling, 2004, and acknowledged by Geels, 2011, p.32), more recent work has emphasised that regimes adapt, respond, and resist pressures to change from the landscape and niche levels. (van de Vleuten and Högselius, 2012; Winskel and Radcliffe, 2014; Geels et al., 2016). Moreover, features that bind a regime together into a strong actor-network (Unruh, 2000) can, by the same token, theoretically facilitate cascading knock-on effects when one element of the system is disrupted (van de Vleuten and Högselius, 2012).

Recognising the multiform nature of transition pathways, and responding to the invitation to take a symmetrical approach to regime stability and change, we report here the findings of an expert survey 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 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 – either due 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.

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, yet 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 paper proceeds as follows. In the next section we set out the research design for the empirical project, presenting the rationale for using a Policy Delphi study to explore experts' views on UK energy system change. Next, we outline how the analysis of the quantitative and qualitative survey data was conducted, before exploring the findings from the analysis in some depth. The paper concludes with some observations about the areas of agreement and disagreement amongst experts on the UK's energy system transition, and considers their implications for research and policy.

Research Design

The Policy Delphi method involves conducting iterative rounds of surveys with the same expert sample, to elicit the range of perspectives on a given topic (de Loë, 2016, p.84). The method was developed in recognition that public policy problems typically have multiple discourses and viewpoints, dispersed by region, role and discipline. Rather than pressing participants towards consensual 'best guesses' (as with conventional Delphi methods), 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 Let 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.

Formed as part of a wider ongoing project on continuity and disruption conducted by the UK Energy Research (UKERC), the two-round study was conducted in two stages between late 2017 and early 2018, with one sample comprised of UKERC members only, and the second comprised of a wider community of researchers and stakeholders, in government and parliamentary bodies, industry and non-governmental organisations.[1] The latter were recruited using a UK Research Council database of energy researchers, stakeholder lists used by UKERC, and through a snowballing technique (Bryman, 2016) with assistance from across the UKERC community, in order to ensure we reached a wide and varied energy stakeholder community.[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 Miles et al., (2016, p.102) and with a keen awareness of the diversity of our intended sample, across different 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.[3]

The survey, which forms part of a wider ongoing project on continuity and disruption in the UK energy system being conducted by the UK Energy Research Centre (UKERC) considers overall patterns of energy system change in the UK, questions of future governance and ownership, the role of citizens / consumers, landscape pressures and system shocks and more sector-specific changes in heat, power and transport. At the end of the survey respondents had the opportunity to comment on UK energy policy and research aims and priorities. Given space constraints we report here on only a few of these areas.

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[1] The two-sample approach reflects our two-fold aims: i) to develop interdisciplinary whole systems relations and insights across UKERC and ii), to draw on the diverse expertise concerned with UK energy system change among senior researchers and stakeholders. Here, to limit the scope and due to time constraints, we focus only on Round 1 results from both samples.

[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.

[3] For the same reasons, we chose 2040 as the year of reference for the survey. This enabled us to strike a balance between a long term outlook (which could elicit more radical 'anything could happen' thinking, and a short term outlook (for which only a narrow array of possibilities would be deemed credible. However, different parts of the energy system are changing at different rates and our use of a single time point (for simplicity) was inevitably a compromise.

Under each survey topic, participants were typically asked to assess the likelihood of different statements about the UK's energy system in 2040. Consistent with de Loë's model for Policy Delphi studies (de Loë, 1995), participants were 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'. They were then asked to explain the reasoning behind their answer with reference to relevant evidence sources supporting it. In this way, the survey goes beyond merely capturing the diversity of expectations amongst experts, by also enabling us to understand the reasoning and contingencies underlying these differences.

With this rich body of data to hand, our data analysis was driven by the following two research questions: *to what extent do experts agree or disagree on the likelihood of more general and more specific aspects of continuity-led and disruption-led change in the UK's energy system between now and 2040?;* and secondly: *in what ways does differences among expert expectations reflect different interpretations of the UK energy system's current state across landscape, regime and niche levels, and system pressures and likely responses*?

Data Analysis

The Round 1 surveys produced a wealth of empirical quantitative and qualitative data. For the quantitative data, de Loë's (1995, p.62) consensus measure was used to calculate a measure of the extent of consensus reached for each statement, using the Likert scale scores. For each statement, the degree of consensus is scored as either none, low, medium, or high, according to the distribution of responses across the four categories. The criteria for rating the consensus depends on the proportion of responses in one single category and on the proportion across two contiguous categories (i.e. likely and highly likely; or unlikely and highly unlikely). Where the scores for one single category and across two contiguous categories differ, the statement is given the highest of the two scores. For example, a statement would have a 'high' consensus score if either 70% of valid answers are in one category, or if 80% of the valid answers are in two contiguous categories.

Table 1: De Loë's consensus measure

Consensus measure	*Minimum criterion for this consensus score in 1 category*	*Minimum criterion for this consensus score in 2 categories*
High	70%	80%
Medium	60%	70%
Low	50%	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. Next, to assist the analyst in eliciting the emerging continuity and disruption narratives in the data, coding from the literature was applied (Blair, 2015) using key concepts from the multi-level perspective (e.g. Geels and Schot, 2007; Geels, 2011) and pressure-state-response framework widely used in environmental systems research (e.g. OECD, 2003; Howard et al., 2011), as summarised in the table below. These concepts were not explicitly discussed in the survey presented to the analysts, but provide a means to systematically categorise and interpret the data.

Table 2: Data Coding

Theoretical Code (Source)	Definition
Sociotechnical Regime	Comments regarding the incumbent network of institutions, actors, infrastructures, and the alignment of their activities that constitute the core of the current energy system.
Niches	Comments referring to the emergent social and technical configurations that may be part of the regime in future.
Landscape	Comments relating to the broader context, generally seen as beyond the direct influence of niche and regime actors. Examples include economic trends, cultural patterns and political movements.
Pressures	Comments about interactions between the regime, niche and landscape levels – e.g. niche innovations placing pressure on the regime, or changes at the landscape level lending support to specific niche innovations
Responses to pressures	Comments about how the niche and regime actors respond to pressures from each other, and from the landscape

In the next section the quantitative and qualitative insights are provided for the whole energy systems questions on the topics of: the nature of the UK's energy transition overall, governance and ownership, citizen and consumer engagement, and energy security and flexibility.

Results

Survey Sample

A total of 129 participants took part in two parallel Policy Delphi studies. 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: Affiliations of the Round 1 Survey Sample

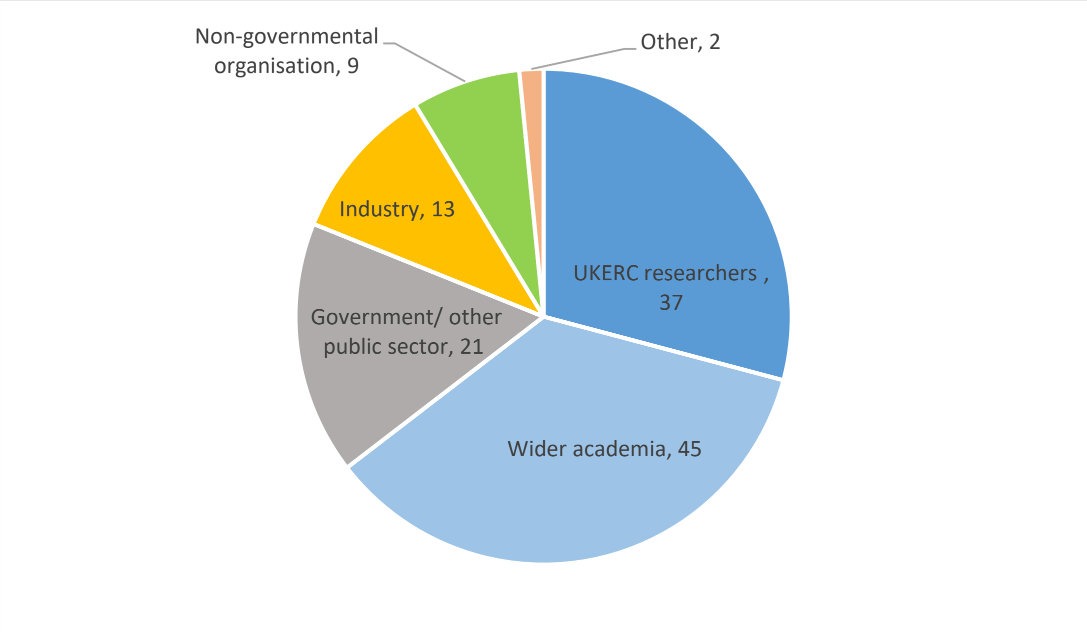
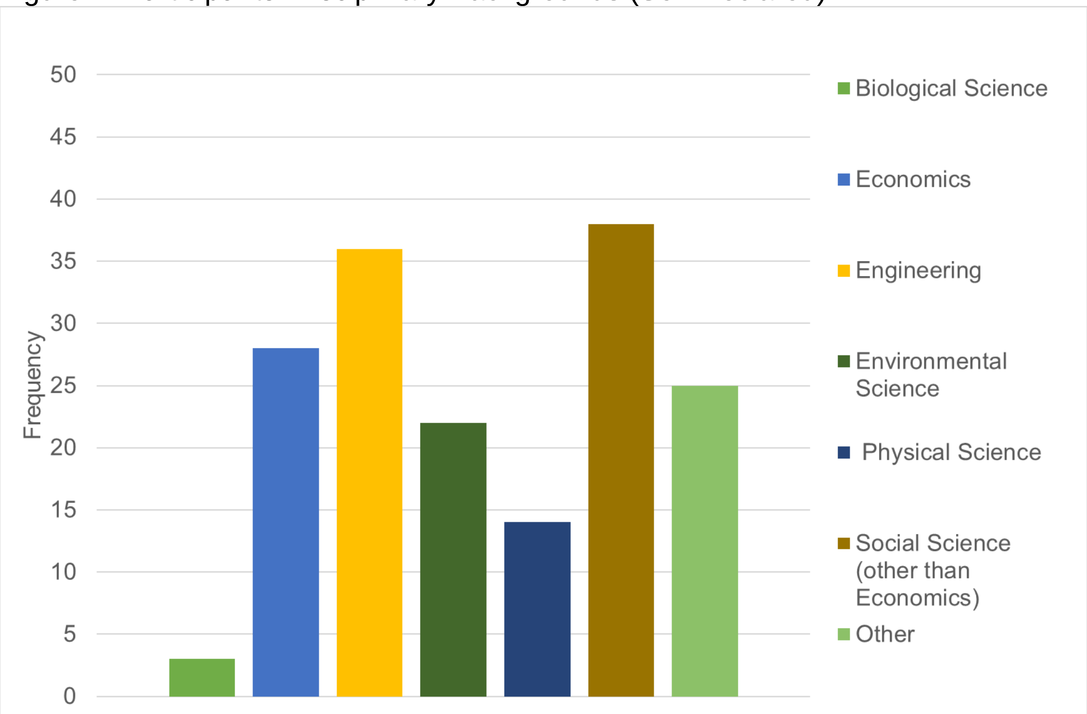


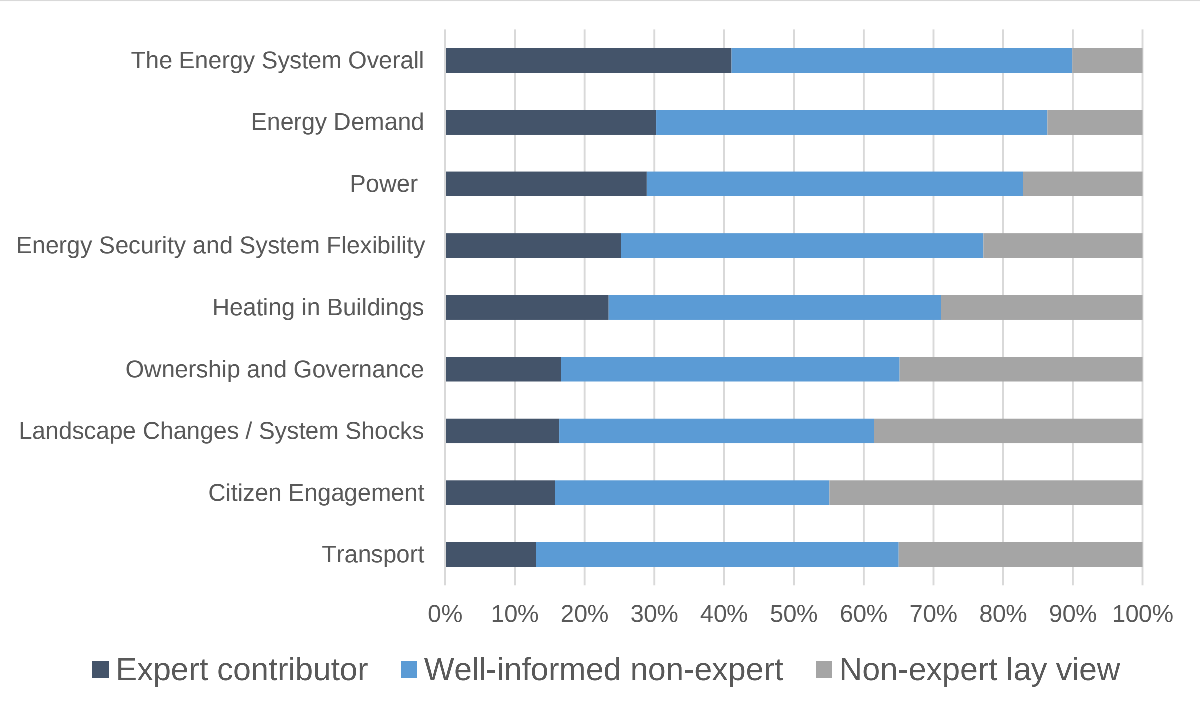
Figure 2 shows the range of disciplines that participants self-identified as belonging to. The results suggest a good spread of participants across natural sciences, engineering, economics and social science. Some of the most common self-declared disciplines participants added under the option of 'other' include: business, complexity science, energy modelling, interdisciplinary research, maths, and operational research, policy, statistics and technology assessment.

Figure 2: Participants' Disciplinary Backgrounds (Self-Declared)



We then asked participants to self-assess their expertise in different topic areas addressed in the survey. Intriguingly, the energy system overall is the category with the highest number of self-assessed experts.

Figure 3: Self-Assessed Expertise



We turn now to the substantive results of Round 1 of the survey.

<u>The Energy System Overall</u>

We first asked participants whether they anticipate the UK energy system will experience highly disruptive changes to infrastructure and organisations, or alternatively continuity-based changes, by 2040. As is clear in the Figures 4 and 5 below, the sample was approximately evenly split on the question, with a no consensus measured for either statement.

Figure 4: Likelihood of a Disruptive Transition

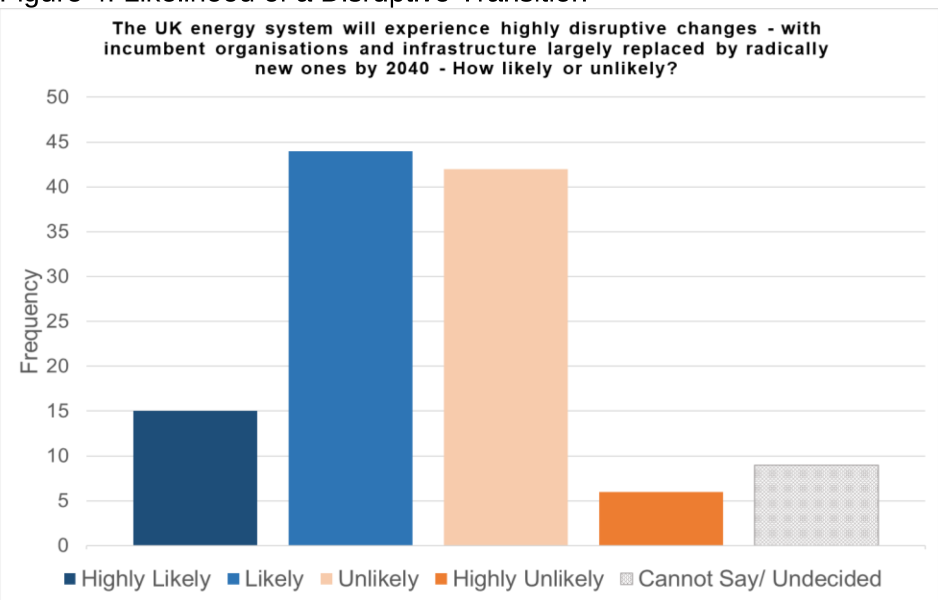
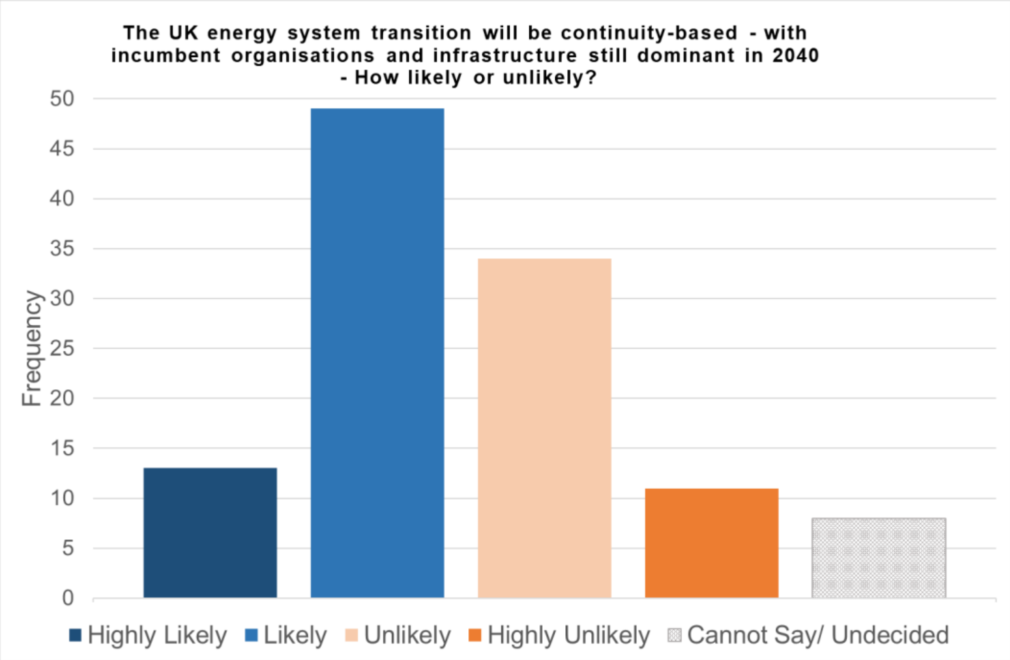


Figure 5: Likelihood of a Continuity-based Transition



Comments on the energy system overall:

Regime Level: Reflecting the split in the quantitative questions, the comments were broadly divided over whether the system would, overall, undergo highly disruptive or continuity-based changes. Those who anticipate disruption highlight a range of issues with the current regime. Some view the existing system as so firmly locked-in that despite a wide awareness of outdated legacy practices, it is not possible to change them quickly. For these participants, new organisations can emerge which are more suited to the pace of change and low carbon landscape, and these are likely to take the place of incumbents. Indeed, some see this as already happening, with large retailers losing market share to new entrants such as Good Energy and local suppliers.

On the other hand, some participants pointed out that while incumbent organisations are under pressure, many are already responding by investing in new business ventures, co-opting niche innovators (through mergers and acquisitions) and are dropping the fossil fuel arms of their businesses. Examples provided include E.ON, RWE, National Grid and distribution network operators. They argue that incumbent organisations will follow a path similar to British Telecom, where the same organisation exists but is a different body than before the transition.

Turning to infrastructure, those who anticipate disruption argue that the existing large scale infrastructure (such as gas turbines and large scale storage) are not as cost effective as they used to be, and all large scale projects nowadays face an investment issue, as they all require government support to make them feasible. This was said to make a case for novel business models or alternatively a shift to more distributed solutions – in either case, causing disruption in the system. Others pointed out that the cost of new infrastructure can be prohibitively high, and the technological complexity of the system, along with locked-in practices and institutions, sunk costs and future investments, make it more likely that infrastructure will be updated than replaced. Gas is cheap, plentiful, flexible and has multiple uses, and is seen by some as here to stay for a few more years.

Landscape Level: The key landscape issues identified by those who view disruption as more likely are: the climate change targets and the urgency this places on the system, the UK’s shift towards becoming a major net energy importer, changing expectations around digitisation, decentralisation and energy services, and a political desire to break up perceived cartels. Those who consider continuity to be more likely also view the landscape differently, identifying uncertainties (over Brexit, the impact of heat and transport on the electricity system) and an apparent lack of appetite for radical change amongst politicians and citizens, as reasons to expect continuity to prevail.

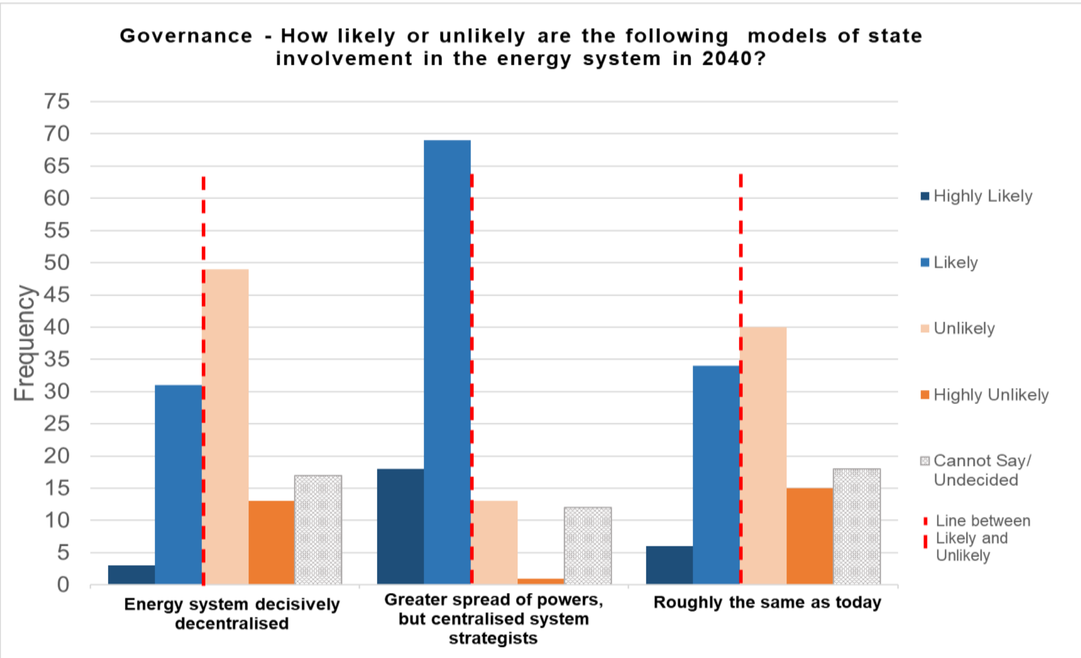
Niche Level: those who expect disruption overall point out that renewable energy technologies are already producing the cheapest form of new generation in many areas, and this, coupled with digitisation and the emerging internet of things, along with local authorities and the Scottish government's interest in adopting new roles as suppliers and system operators, all point to the likely emergence of new business models and consumer-supplier relationships. However, others maintain that high market entry costs and regulations can make it difficult for new niche innovations to drive disruption, while other innovations to enable the repurposing of the national gas grid for hydrogen and the emergence of carbon capture and storage technologies are likely to reinforce the current regime, and enable it to transition.

Pressures and Responses: the landscape is changing quickly, with climate change targets, security of supply concerns, and the drive to decentralisation all exerting significant pressure on the system to change. Incumbents are seen as likely to co-opt their challengers, through mergers and acquisitions. Government policy is slower than the pace of change, and is protecting incumbents, but technological advances and reducing costs may well lead to disruption regardless. In contrast to the claim that the UK's status as a net importer supports the case for disruption, others view the imperative of security of supply as implying a need for incremental change with enhanced national infrastructure.

Governance

Regarding the governance of the UK energy system, we asked participants to assess the likelihood of more or less decentralised governance in 2040. As is clear in Figure 6 below, each of the three statements attracted mixed responses. Statement 2, which is the moderate scenario for this question, saw a high level of consensus (likely/ highly likely), while there was a low level of consensus around 'unlikely' for the high-disruption scenario, and no consensus for the continuity-based change scenario).

Figure 6: Governance of the UK Energy System in 2040



Comments on system governance:

Regime Level: At the regime level, there was widely shared recognition that governance arrangements for energy are changing in the UK, with, for example, powers increasingly being devolved to Scotland and Wales. It was pointed out that governments are encouraging local authorities to plan their own energy strategies and that local authorities are starting to invest in their own energy infrastructure too, and these could lead to the disruption of current governance arrangements. These changes were said to be driven by reductions in local authorities' budgets leading them to look for new revenue streams, and also by citizens' demands at a local and regional level, particularly around air quality concerns.

On the other hand, those who anticipate a more continuity-based pathway for governance arrangements expressed doubt that the UK Government will significantly relinquish control over the UK's energy system transition, and it was claimed that new large infrastructure and technology projects such as Hinkley Point C nuclear power plant reinforce the UK Government's continuing central coordination role.

Landscape Level: Participants disagreed over the extent to which devolution has affected the political landscape in the UK. Some see devolution as political common-ground for the left and right, citing the Labour Party's claims that regional networks should be in public control alongside the UK Government's Helm Review case for publicly-owned system operators at a regional level. A small number of participants claimed that a Jeremy Corbyn-led Labour Government would be more likely to pursue devolution than the current UK Government.

In contrast, other participants, who anticipate continuity-based change in the energy governance arrangements, emphasised that the UK has a long-standing centralising political culture that is widespread across the spectrum of political issues, and is not under any substantive systemic threat. In line with this view, it was said that UK citizens are often concerned by regional inequalities, and so efforts towards greater devolution are likely to be limited.

Niche Level: In terms of niche activities, some respondents pointed to local authorities setting up their own energy companies. Others observed that technological innovations including energy generation solutions and infrastructure to support local smart grids may facilitate further devolution of energy policy issues in future, by enabling the control of a local system.

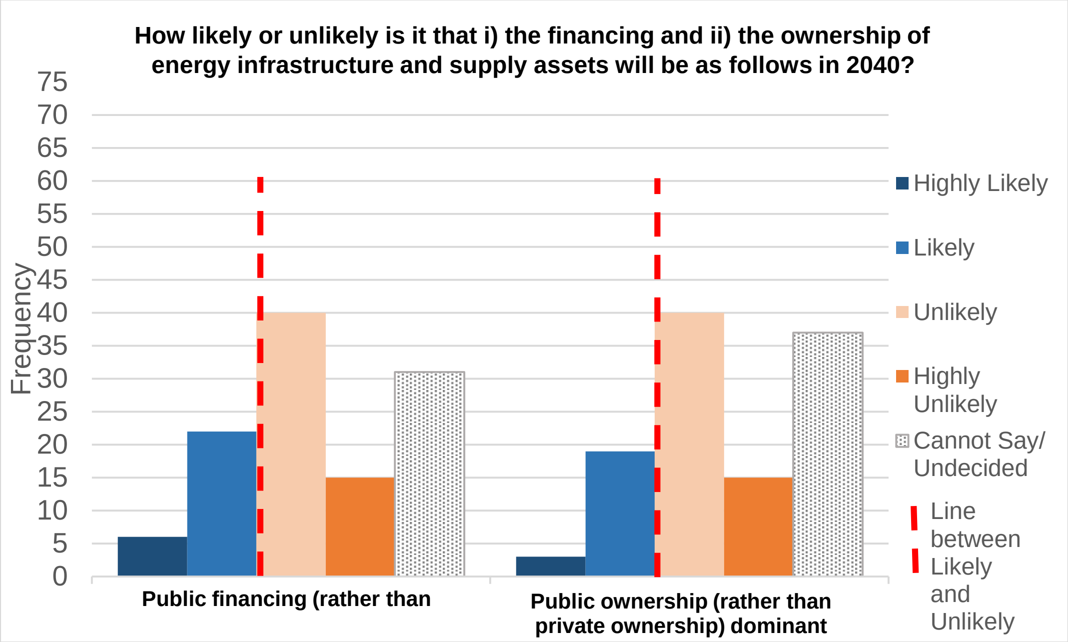
Pressures: two key pressures for the current governance arrangements were identified. First, it was stated that the emergence of localised energy generation solutions and technological innovations that can enable local smart grid control could, in combination, facilitate more devolved control of energy systems in future. Second, it was stated that the potential impact of climate change on the UK's national infrastructure could make a strong case for more localised energy systems.

Responses: Some participants noted that the UK Government still has an important role to play in ensuring that the UK has stable has stable access to secure energy supplies, such that they would be held accountable for any supply failings. As many local areas and regions are unlikely to supply all of the energy required locally at the time required, it is expected that large-scale projects will still play an important role in the network, and these will require UK Government support, planning and involvement. This was seen as a reason why current arrangements are likely to continue, and could form part of incumbents' case against further devolution. Second, the energy system was seen as facing big challenges (such as the electrification of heat and transport, decarbonisation) that require central coordination and access to evidence and expertise, and that the UK Government would be best-placed to access this.

Finance and Ownership

We asked participants about the funding and ownership of energy infrastructure and associated assets in the UK in 2040. Figure 7 below shows that there was a high level of disagreement here, with a slight tendency towards the unlikely categories, and a high number of participants undecided or unable to say.

Figure 7: Financing and Ownership of energy infrastructure and supply assets in 2040



Comments on finance and ownership:

Regime Level: The question of how the energy system transition is likely to be funded received mixed responses. It was generally appreciated that current infrastructure assets are ageing and the system faces considerable challenges around decarbonisation and security of supply. The scale of investment required was seen as particularly problematic, with many saying that state finance would be better spent in other ways than nationalising infrastructure assets. Nonetheless, a wide range of views were expressed about the current financing arrangements for energy infrastructure and assets in the UK, and how they are likely to change. A few participants believe the current predominantly market-based model of financing has been successful and is the only realistic option for large energy infrastructure, with government playing an important role ensuring that the market is regulated. But a handful of participants consider private financing initiatives (which are used by the UK Government to underwrite private investment for large scale projects such as Hinkley Point C) to have been discredited, and expect to see alternative, public financing mechanisms being tried in the future. It was, however, noted that the Green Investment Bank has been privatised, making it less likely that there will be significant national public financing in the future.

The issue of ownership was less prominent in the comments. Some participants ruled out the idea that the state might nationalise infrastructure assets, with an estimate that this could cost £100 billion and that could be better spent elsewhere. In addition, it was also suggested that assuming heat and power systems remain centralised, then public ownership of assets would only be possible for regional transport systems. One participant claimed that that the framing of the question in terms of public and private ownership is problematic, suggesting that ownership could be spread heterogeneously across communities, individuals, industrial groups and not-for profit actors. UK.

Landscape Level: A small number of landscape issues were identified by participants. In terms of politics, it was recognised that the future financing and ownership of UK energy infrastructure and assets depends significantly on election results (hence the high number of undecided/cannot say), with many seeing a Labour Government as more likely to support public ownership and financing than the current UK Government. Some suggested that Labour Party leader Jeremy Corbyn's recent rhetoric has opened up possibilities that were not seen as credible for many years. This is consistent with a reference that was made to Carlotta Perez's research on long waves in technology and society (e.g. Perez, 1985), which suggests that the pendulum of public opinion swings over periods of decades, and therefore we might expect a swing back towards public ownership before 2040. But it was also pointed out that currently Brexit is overshadowing the political climate, and it is unlikely to enable a bold domestic agenda to emerge. Austerity was described by a few as restricting public investment – but some see austerity as providing an incentive to local authorities to invest in energy projects for additional revenue streams. Others emphasised the importance of the economy, pointing out that the government is more likely to invest in energy infrastructure when the economy is doing well.

Niche Level: Some participants pointed out that public ownership models are currently being tested out in Scotland, Liverpool, and Leeds, with the Scottish Government likely to launch a publicly owned energy supply company which could also invest in energy infrastructure. In acknowledgement of the high costs of large scale projects, it was also claimed that currently public financing and ownership would work better for small scale projects, but this might change through the use of new energy trading platforms such as blockchain.

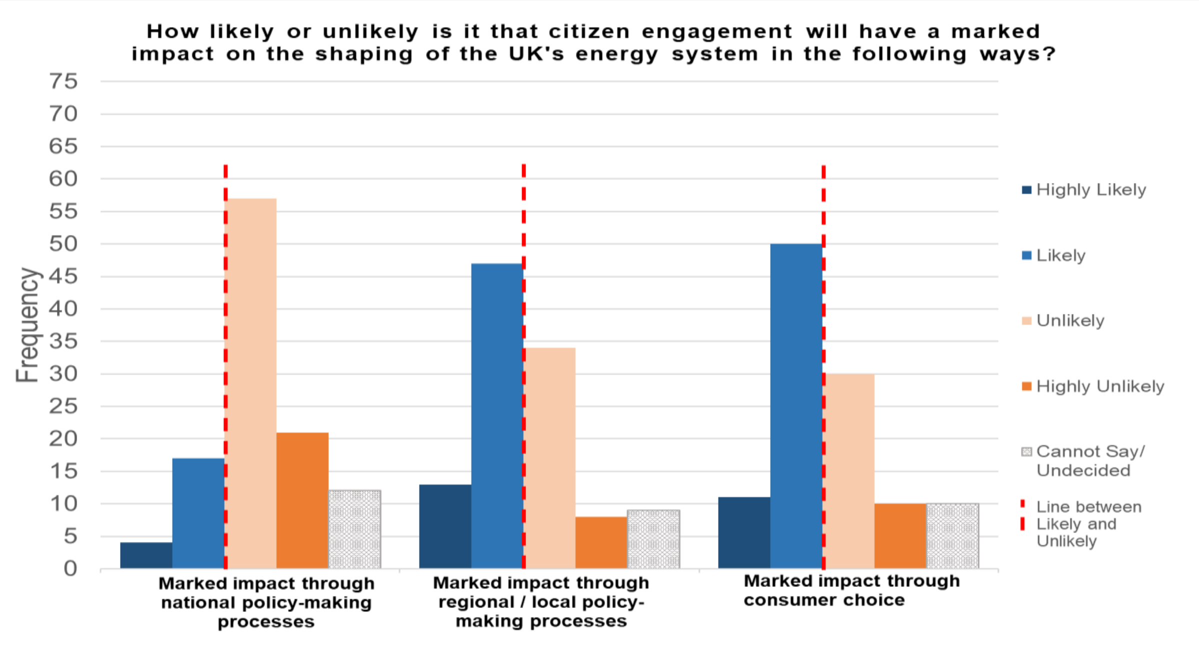
Pressures: Two key sources of pressure were identified. First, it was claimed that concerns about security of supply and decarbonisation are putting pressure on energy suppliers to adapt in ways that they are unable to, thereby making space for new entrants such as not-for-profits to emerge. Relatedly, it was suggested that private investment in the energy system transition has been low in recent years, and this could make public intervention necessary in the coming years, which in turn could change public opinion on the acceptability of private ownership of energy infrastructure and associated assets.

Responses: A handful of participants expressed the view that incumbents are likely to resist pressures to change, pointing to system lock-in and the high costs associated with large-scale projects. It was also said that privately owned utilities are unlikely to act in line with UK Government policy objectives unless there are incentives to do so.

<u>Citizen and Consumer Engagement</u>

We asked participants how likely it is that people will have a marked influence on the shaping of the energy system through engagement *qua* citizens or consumers by 2040. Figure 8 shows respondents' responses to the citizen and consumer engagement statements in Round 1. Clearly, participants held higher expectations for citizens' impact at a regional than national level engagement. Consumer choice was seen by most participants as the mechanism that is most likely to achieve a marked impact on the UK energy system by 2040.

Figure 8: The Role of Citizen and Consumer Engagement



Comments on Citizen and Consumer Engagement:

Regime Level: Many participants noted that citizens have limited opportunities to inform national decision-making processes. They pointed out that general elections can provide an important mechanism for this, but that energy issues are rarely influential in these elections. Others described UK energy policy as too complicated and technical for citizens to be directly engaged, or claimed that citizens are not interested or feel powerless to engage in energy policy. Some of these participants claimed that non-government organisations have conventionally had an important role as a voice for citizens in these processes, but this has been diluted by successive UK Governments in recent years.

In addition, the UK Government's commitment to fracking irrespective of some public concerns and protests was described as indicative of the UK Government's unwillingness to involve citizens in their processes. There were higher expectations about the impact of citizens at the regional or local level. Direct action over local infrastructure issues such as shale gas, nuclear and wind turbines were seen as influential on local and regional policies. Participants also pointed to planning processes, sustainable energy action plans and local budget processes as all providing mechanisms for citizens to influence decisions.

Landscape Level: The only comments about landscape issues concerned i) the possibility that a Labour government might take steps to open up national energy policy-making processes, and ii) the notion that consumer energy prices are currently cheap and are likely to remain so.

Niche Level: Many participants envision citizens as a disruptive force in the energy system, in the sense of consumers buying into niche innovations. One mechanism for this would be consumers switching energy suppliers. Some participants believe there is evidence that this is beginning to happen now, citing an article claiming that 140,000 consumers switched suppliers in 2017. It was also suggested that smart meters could automate the process of consumer switching, making it more convenient. But other participants saw little evidence that consumer switching is taking off in the UK. Moreover, it was pointed out that even if consumer choice has the power to impact the energy system, it is not clear whether it will necessarily cause disruption, or alternatively, reinforce the current system.

Last, some participants discussed broader changes in the energy system which could change citizens' power in it. Citizens might be empowered in the policy process if the energy system becomes more heterogeneous, with new roles as prosumers, community project stakeholders, and participants in local and regional decision-making. Yet, their powers could also be diminished if 'silver bullet' technological solutions are imposed such that consumers are locked in to new systems. This was described as particularly concerning with heat infrastructure.

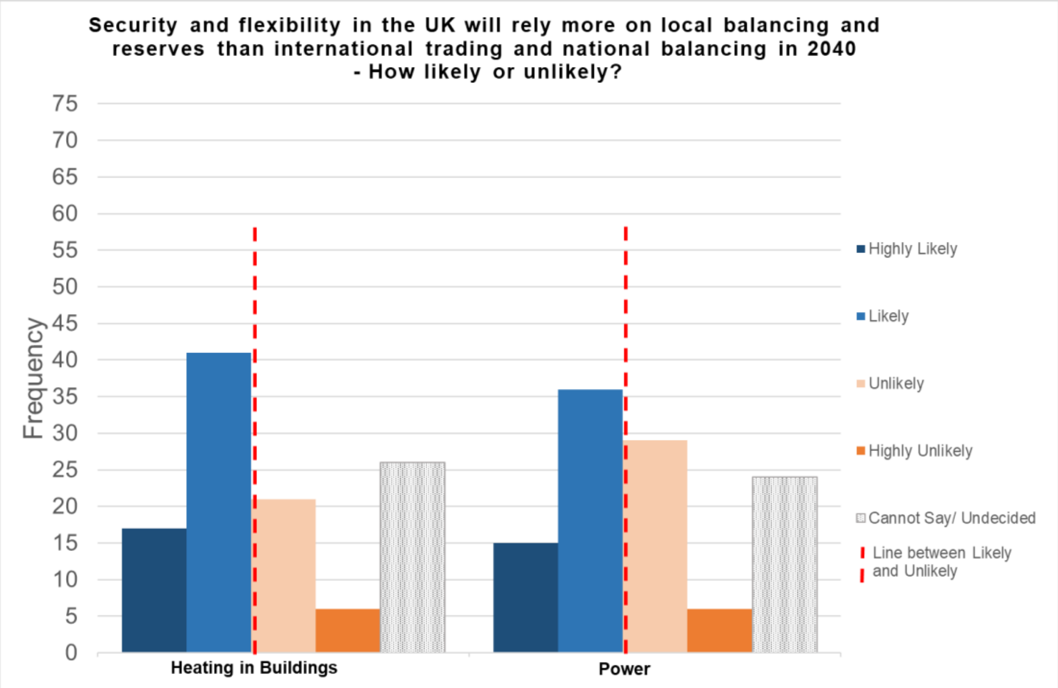
Pressures: The drive to decarbonise energy systems is seen as supporting innovative activities and alternative energy solutions (especially at the local level), while also empowering citizens to engage more with the energy system. Ofgem's future network regulation consultations are seen as one example where decision-making is opening up to listen to consumers' concerns more. There was some concern expressed, however, that increased consumer involvement might result in less evidence-based policy-making processes.

Responses: One framing of localised energy solutions sees them as a cause of 'grid defection'. From this perspective, if a high number of consumers quit using national infrastructure, then the total number of consumers using that infrastructure will drop, causing prices to rise and increasing the number of people in fuel poverty. This framing supports a case for reinforcing the existing grid infrastructure, and is expected by some participants to be incumbents' likely response.

<u>Security and Flexibility</u>

Participants were asked how likely it is that UK energy system security and flexibility will rely more on local balancing and reserves than on international trade and national balancing, for heating in buildings and power respectively. Figure 9 and the chart below show that there is no agreement on this topic. However, there is a slight leaning among participants towards the view that this would be more likely for heating in buildings than for power, with a medium level of consensus that this is likely/highly likely for heating in buildings, while no consensus was found on power.

Figure 9: Security and Flexibility in 2040



Comments on Security and Flexibility:

Regime Level: For the heat system, many participants believe that the UK could rely on national solutions and international trade in the future, especially if it continues to rely on natural gas in the 2020s and 2030s. The latter point was seen as likely by many, with references made to the National Grid's Future of Gas Progress Report (2017) and a Heat Infrastructure Paper produced by Imperial College in 2016 (Maclean et al., 2016). At the same time, some participants see an inherent advantage for heat balancing to be addressed locally, as heat (unlike gas) cannot be transferred over large distances.

Regarding power, it was pointed out that if all of the projects in development completed, there will be 17GW of interconnection capacity available. Yet, it was also said that interconnectors can be burden as well as a resource, as in winter 2016/17 nuclear power outages in France led the UK to export electricity at a time when it would normally import. Moreover, some pointed to a growth in local energy systems, and these might play an important role if incumbents aim to reduce import dependence, particularly after Brexit.

Landscape Level: Besides the pressures associated with decarbonisation, the only other landscape issue discussed by participants is Brexit, which could lead to the favouring of local solutions over international interconnectors.

Niche Level: Participants pointed to different types of innovations to support their view about whether security and flexibility will rely more on local or international/national solutions. Those who anticipate local solutions to prevail pointed to the potential use of smart meters to enable demand-side management and the local control of networks. They also highlighted a recent project by Electricity NW to reduce load and manage energy demand through voltage reduction, and pointed out that solutions are likely to be regionally variable as they will depend upon local preferences and access to resources such as biomass and thermal storage.

Others made the case for international trading and national storage or aggregation solutions, suggesting that economies of scale would work against local solutions for security and flexibility. Furthermore, if demand curves are flattened through demand reduction and energy efficiency, then local balancing will be less cost-effective as a solution. Both groups of participants invoked the issues of heat electrification and electric vehicles to emphasise the importance of their preferred innovative solution.

Pressures: A combination of pressures were identified. First, decarbonisation is restricting the use of conventional security and flexibility solutions, such as gas and coal, and driving the system towards renewable generation solutions, such as wind and solar power, which are intermittent and therefore riskier from a security and flexibility perspective. At the same time, the uncertainty over the future of heat infrastructure and the pace of growth of electric vehicles present additional challenges to the regime.

Responses: Some participants maintain that the national infrastructure will still have an important role to play in the 2020s and 2030s, and it provides an important back-up function for exceptional circumstances, such as long periods of freezing cold weather, or low wind/solar power production.

Summary and Conclusions

There is considerable disagreement amongst UK energy experts on critical issues facing the UK's energy system transition between today and 2040, and on the extent to which the transition is likely to be continuity-based or disruption-based. On the vast majority of issues, we found low or no consensus including: whether energy system organisations and infrastructure are likely to undergo continuity or disruption-based change overall; whether energy infrastructure and supply assets will be predominantly privately- or publicly-owned or financed; whether citizens will have a marked impact on regional energy decisions, whether the security and flexibility arrangements for power are more likely to rely on local balancing and reserves or international trading and national balancing.

In some areas, we found a degree of consensus – with, for example: medium or high levels of agreement that governance arrangements are likely to result in a greater spread of powers but with UK national strategists remaining dominant; citizen engagement at the UK national level will be unlikely to have a marked impact on national policy-making processes; and security and flexibility arrangements for heat are more likely to rely on local balancing and reserves than international trading and national balancing.

Analysis of the qualitative data enable us to probe deeper into these results. It reveals two key reasons for divergence amongst UK energy experts. First, there are *alternative framings*: issues which different experts view through a different lens. For example, some see the emergence of local energy systems as an efficient, cost-effective solution which is permeating the UK energy landscape, with the potential to beneficially disrupt the existing regime and replace dominant infrastructure. Others, however, frame local energy systems as an undesirable development, because sunk investments and locked-in practices mean that maintaining and adapting current infrastructure is the most cost-effective, equitable and secure means of achieving the desired energy system transition.

Besides competing framings, there are also *contested issues* within the same frame, in terms of varied preferred responses to similar pressures. For instance, participants were generally agreed that decarbonisation and security of supply concerns are placing pressure on the system, but while some see it as possible for utility companies to co-opt challengers and/or adapt their businesses, others view utilities as too locked-in and inflexible to respond adequately, making them vulnerable to overthrow. Similarly, many participants view the costs of infrastructure as a key influence on energy system transition, but there was no agreement over whether replacing national infrastructure would be more cost-effective than incrementally changing or repurposing it.

The analysis does reveal some areas for which there is some evidence of 'closure' (Geels and Schot, 2007, p.405), although more research is needed to confirm whether this is reflected more widely across the energy community. Examples include the observation that policy-makers do not appear to have a strong appetite for driving disruption-based change at present, the costs of renewable energy technologies are changing dramatically with significant impacts on the energy system, governance arrangements for energy issues are changing across the UK (although the limits of this are contested) and current large scale energy infrastructure assets are ageing and in some cases becoming less cost-effective. More research is needed to explore the implications of these findings for the development of future energy scenarios.

Overall, the survey results capture a significant body of whole energy systems expertise in the UK, across academia and beyond. The absence of consensus on the likelihood of disruption-based or continuity-based transition in many areas – from the overall system, particular sectors and specific innovations – suggests the need to consider both disruptive and continuity-based aspects of UK energy system change and system integration. Disruption-based narratives and radical visions capture only part of the uncertainty (and decision) space facing energy futures, and in some areas, a transition with significant elements of continuity is seen as likely – with the future perhaps looking more like the present than radical and disruptive visions suggest. For transition researchers, the need is to carefully examine the evidence and compare alternative paths.

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