Disruption and Continuity in the UK Energy Transition: What do the experts think?

Results of the UKERC and CXC survey of UK energy experts and stakeholders

Briefing note by Dr Mark Winskel and Dr Michael Kattirtzi (University of Edinburgh)



April 2019

Introduction

The way we generate, distribute and consume energy is changing, and many observers anticipate accelerated changes ahead. These transformations are being driven by a combination of policy and regulatory pressures, rapid movements in the cost and performance of some energy technologies, and shifting patterns of consumption and behaviour.

At the same time, energy systems often display continuity-based change, in terms of the extension, renewal and repurposing of existing technologies and organisations. Both disruptive and continuity-based pathways of change are reflected in the varied expectations about energy futures among researchers, businesses, policymakers and civil society.

In the UK, some aspects of energy futures are generally agreed, particularly the need for near wholesale decarbonisation over the next few decades while providing secure and affordable energy. However, there are differing expectations about the most effective and desirable way to achieve an energy transition. Policy and investment decisions are often needed despite such disagreement, and with only a partial or unclear evidence base.

Against this backdrop, this Briefing Note presents the findings of a detailed survey of energy researchers, policymakers and stakeholders. The survey was developed and funded as part of a wider research project on 'Disruption and Continuity in UK Energy System Futures' carried out by the UK Energy Research Centre (UKERC); it was subsequently co-funded by ClimateXChange (CXC), Scotland's Centre of Expertise on Climate Change.

The survey was designed to explore differing views about UK energy system futures in terms of two alternative 'transition logics': a ***disruptive logic,*** in which the UK energy transition involves dramatic changes over the next two decades, and a ***continuity-based logic,*** in which the transition involves mostly adapting and repurposing existing technologies and organisations (Figure 1). Because the UK energy system remains, for the most part, highly centralised around large scale technologies, networks and organisations, the UK's disruptive transition path involves a significant shift toward decentralisation.

Figure 1: Survey design – logics of disruption and continuity

- In a **Disruption-based transition,** policies, technologies, business models and behaviours provoke a fundamental remaking of the UK energy system.
- Existing organisations and infrastructures cannot respond sufficiently and are largely displaced.
- Wide-ranging decentralisation of the system, both technically and organisationally.
- End users and the wider public become more actively involved.

- In a **Continuity-based transition,** system change is pursued mainly by adapting and repurposing existing organisations and infrastructures.
- New technologies, business models and behaviours are adopted as extensions and adaptions of existing ones, in order to meet policy objectives.
- Large scale technologies and organisations remain vital; national strategy and regulation dominate.
- End users and the wider public remain largely passive.

The survey questions invited respondents' views on these alternative transition logics for a wide variety of energy issues, both across the energy system as a whole, and more specific changes to heat, power (electricity) and transport sectors. The survey included over twenty questions, making it one of the most detailed analyses of its kind ever undertaken.

The questions covered respondents' perceived ***likelihood*** of different energy futures over the next two decades, and also their ***preferred*** policy and innovation priorities (Figure 2).

For each survey question, participants were asked to assess different propositions about the future of the UK energy system (in most cases using a 4-point 'Likert' scale, from 'highly likely' to 'highly unlikely') and then explain their reasoning, including references to any relevant sources of evidence. In this way, the survey results not only map the different expectations and preferences of UK energy stakeholders, but offer explanations for any differences of view.

The year 2040 was chosen as a standard end-point for most of the survey questions. This strikes a balance between a very long term outlook (inviting 'anything could happen' thinking), and a short term outlook for which only a narrow range of futures might be considered. However, as different parts of the energy system are changing at different rates, shorter or longer time horizons were used for some questions.

The survey was conducted over two rounds in late 2017 and in early 2018. Round 2 participants were invited to comment on the first round results and consider revising their own views – a survey design known as the 'Policy Delphi' method. This is a widely used elicitation method, based on the benefits of interaction and iteration. Rather than forcing a 'false consensus' to support single-point forecasts, Policy Delphi recognises that public policy problems typically have multiple viewpoints, dispersed by respondents' role, place and discipline.

Almost 130 people completed Round 1, and 70 also completed Round 2. Respondents covered a wide range of experience and expertise: approximately one third were academics working within the UKERC research community, another third were senior academics drawn from the 'whole systems' theme of the UK Research and Innovation (UKRI) energy research programme, and the final third were non-academic energy stakeholders, including policymakers, businesses and non-governmental organisations. A good mix of disciplinary backgrounds was achieved across researchers – from engineering, social and environmental sciences – and non-academic professionals covering a mix of established and emerging interests in the energy sector.

In terms of expertise, most of the respondents saw themselves as having – at least – a well-informed view for each of the topics covered by the survey. Expertise levels varied across the different survey topics, with higher levels in some areas (whole systems, energy demand, the power sector, and heating in buildings) and lower levels in some others (transport, system ownership and financing, and citizen engagement). Rather than a highly specialised expert base, the overall sample represents a mix of generalist and specialist energy expertise.

Figure 2: Survey structure

Section 1: Participant information

- Academic or professional background
- Disciplinary or professional background
- Level of expertise on different energy issues

Section 2: Overall energy system change (the 'likelys')

- Overall views on continuity and disruption
- Governance and ownership
- Role of citizens and publics
- Security and flexibility
- Changes in demand
- Landscape pressures and system shocks

Section 3: Heat, power and transport

- Overall character of sector change
- Most important contributions to change in the sector

Section 4: Policy priorities (the 'shoulds')

- High level policy aims
- Specific policy priorities
- The UK energy research system

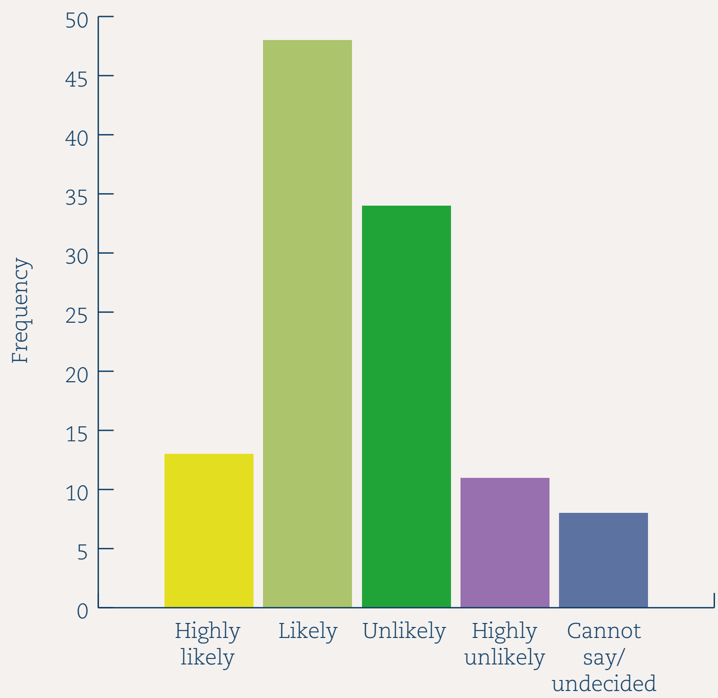
Overall findings

The results reveal widely varied expert and stakeholder expectations about UK energy futures. While there were some areas of agreement, there were also many areas of disagreement – across the system as a whole and many of its parts. Differences of view were enduring – the majority of second round survey participants did not change their views in light of others' views. (This Briefing Note mostly focusses on Round 1 results). At the most general level, respondents were roughly evenly divided on whether UK energy system was likely to undergo a disruptive or continuity-based transition over the next two decades (Figures 3 and 4).

At the same time, there were other areas of broad consensus among respondents; key areas of agreement on the likely character of the UK energy transition to 2040 included:

- The UK's transport transition will be dominated by technological substitution. By contrast, there was much less agreement about the role of changes in practices and behaviours, such as service demand reductions and modal shift.
- For heating in buildings, national infrastructure will continue to dominate, but with an emerging patchwork mix of supply technologies at different scales. Local, municipal and community-based provision is unlikely to dominate.
- In terms of overall policy powers, there will be a greater spread of energy policy powers between UK, devolved and local bodies, although central government, regulators and system operators are expected to continue as the main system strategists.
- While there will be little change in public involvement with national energy policy-making, citizens will be more influential at the local and regional levels, and in exercising individual consumer choice.
- Final energy demand is likely to decrease moderately from today (i.e. by between 10% and 30%), both for the energy system as a whole and in the buildings and industry sectors. However, for transport, there is a mix of likely changes that could lead to either increased or decreased demand.

Figure 3: Likelihood that the UK's energy system transition will be continuity-based – incumbent organisations and infrastructures will still be dominant in 2040, albeit re-purposed and/or adapted



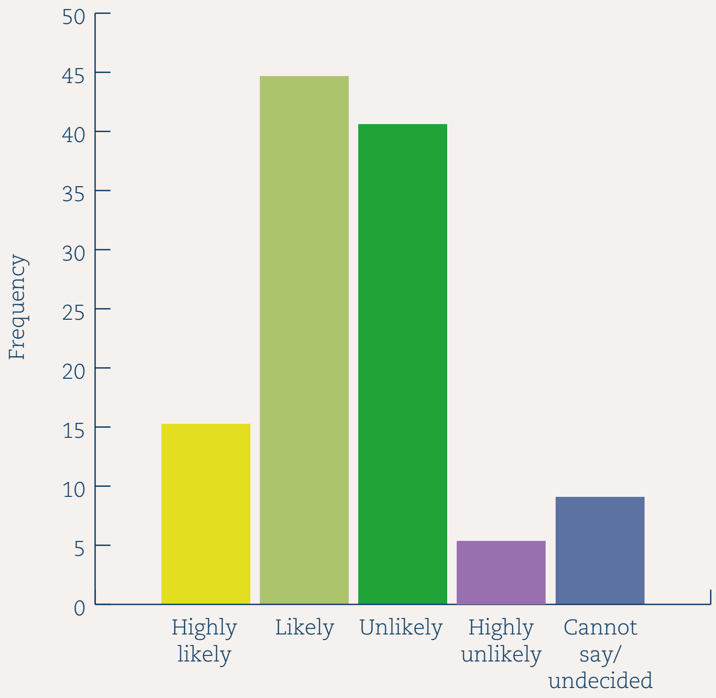
"I think the energy system will go through significant change but that incumbents will be part of that change"

Director of a public-private partnership

"All industries that deliver at low cost have high degrees of standardisation and economies of scale."

Independent consultant

Figure 4: Likelihood that the UK's energy system transition will be highly disruptive, with incumbent organisations and infrastructures largely replaced by new ones by 2040



"New organisations will emerge without the baggage of legacy practice and will find it easy to become profitable doing what the incumbents are not structured to do."

Professor of engineering

"The scale of financing needed to fully decarbonise the system is beyond the balance sheet of the traditional incumbents."

Senior economist at a large NGO

Whole system change

The broad divide among respondents on whether the UK was likely to undergo a disruptive or continuity-based energy transition covered both technological and organisational aspects: on whether existing technologies and networks would be adapted or replaced by new ones, and whether established (or incumbent) groups would adapt or be displaced and/or resist change.

There was some consensus that centralised system strategy-making and large scale technologies and infrastructures were all likely to continue to play a very important role, under mostly private ownership and financing. At the same time, most respondents expected a growing role for local and regional energy systems and also for demand side management. While the majority of participants expected to see little change in public involvement with national energy policy-making, most also agree that citizens will be more influential at the local and regional levels, and that consumers will have more influence in exercising choices over energy provider, fuel type and origin.

There was disagreement on how energy security and flexibility will be provided in the future, from either distributed and local provision, or large scale national and international sources. For heating, these security and flexibility issues related to uncertainties about heat supply futures and the continued role of gas, while for power, the concerns were about the reliability of distributed sources of security and flexibility (Figures 5 and 6). Compared to more generalist energy experts, security and flexibility domain experts considered it more likely and preferable that the UK continues along a path of predominately centrally managed, large scale sources of security and flexibility.

Figure 5: Energy security issues for heating

To guarantee security of supply, the government will always prefer to have 'control' of the national infrastructure.

An academic researcher

There is now much less gas storage in the UK, so dependency on (potentially unreliable) pipeline and LNG imports will be increasing.

A senior manager at a sustainability NGO

Grid supplies will be needed for insurance. We have to plan for exceptional circumstances (e.g. two-week winter freeze with no wind/sun).

An advisor to the Welsh Government

Figure 6: Energy security perspectives for power

Energy system stability at the national/ international level requires large utility management.

A senior academic researcher

Security of supply is a software [issue] (including market regulation), not a hardware issue.

A director at an environmental think-tank

Will local regions be able to supply all their power (given the uneven distribution of renewable resources) ... Why would this not be better centrally planned?

A senior academic

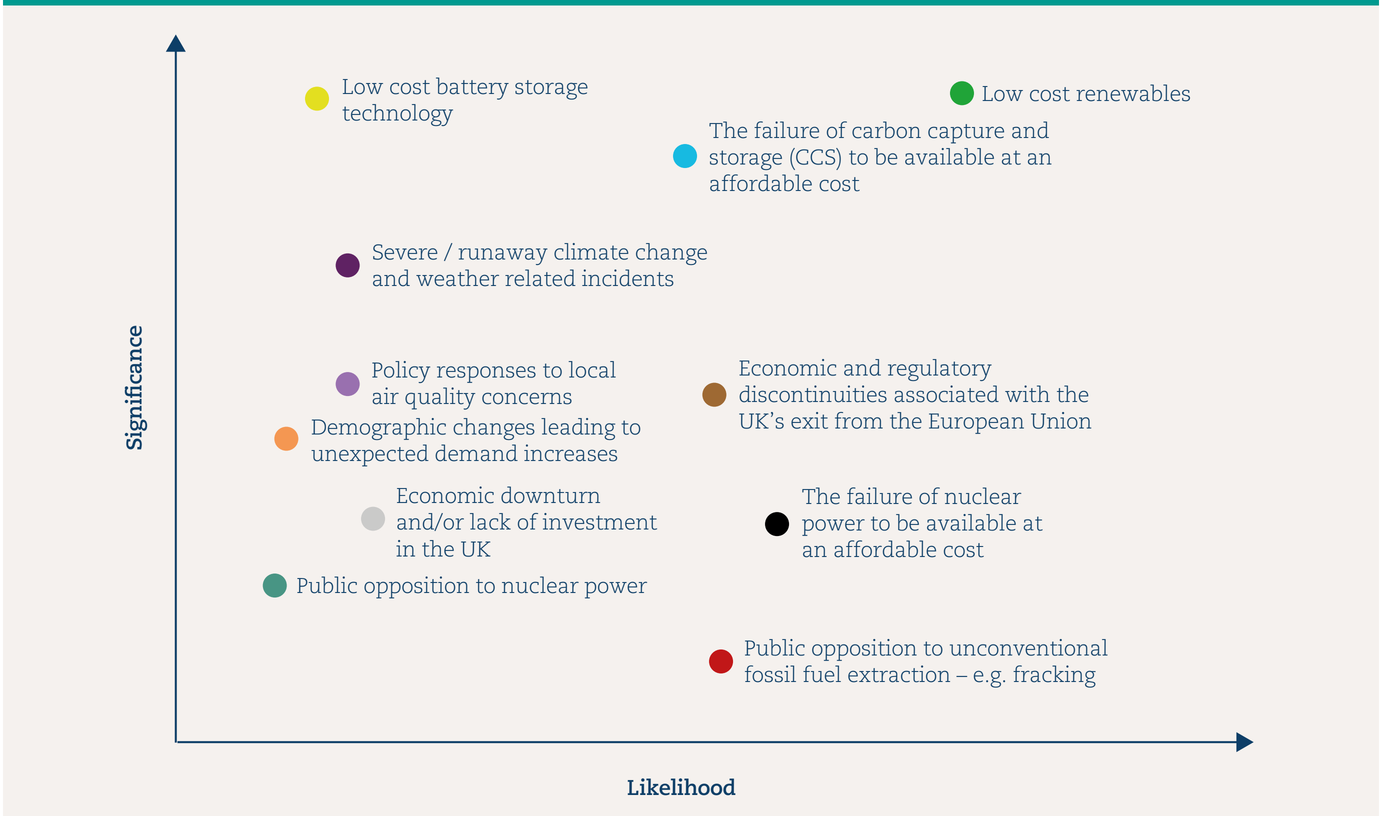
Deployment of electric vehicles means that there will be large amounts of battery storage capacity stationary and potentially connected to the system at any given time.

A senior analyst at an independent public body

On final energy demand (the total energy consumed by end users, excluding energy used in conversion), the survey revealed a high degree of consensus that by 2040, demand was likely to decrease by between 10% and 30% from today, both for the energy system as a whole and in the buildings and industry sectors. However, for transport, there was no consensus on whether demand was likely to increase or decrease, and respondents identified a mix of changes that could lead to either increased or decreased demand.

The results also highlighted a range of possible 'shocks' and changes to the international energy landscape, and broad socio-economic changes that – though they lie mostly beyond UK energy stakeholders' control – need to be taken into account in planning the UK's energy transition. These include both broad social, economic and environmental disruptions, and more conventional energy policy issues for which the UK may play a limited role in wider international developments (Figure 7).

Figure 7: Landscape changes and system shocks – most likely



Heat sector

Heating is an area of broad uncertainty and disagreement on UK energy futures. Most survey respondents believed the UK heat transition up to 2040 is likely to be characterised by continuing reliance on national infrastructure, but with an emerging 'patchwork mix' of different low carbon solutions. Demand-side measures were seen as more important contributors to the heat transition than supply related changes over this period – especially improvements to building fabric (improved insulation and conservation). Changes in consumer behaviour and practices were not expected to make significant contributions over this period – indeed, consumer resistance was seen by many as a barrier to change.

On the supply side, the overall view was of only limited scope for change by 2040, given perceived technical, economic and political barriers. Concerns about the cost effectiveness, scalability and consumer acceptability of different low carbon heat supply options lay behind different views on the most likely pathway for the UK heating transition, though buildings scale heat pumps were seen as the most significant heat supply innovation, with local heat networks also playing a role. Hydrogen-based solutions were viewed as less important over this period – and academic researchers were more sceptical than other stakeholders that gas grid repurposing would play a significant role by 2040, citing concerns around hydrogen production and the availability of carbon capture and storage (CCS).

Electricity (power) sector

Respondents saw a mix of disruptive and continuity-based influences at work in the UK power sector. Key areas of disagreement and uncertainty included the future viability of large-firm business models and the continuing importance of economies of scale. Those who considered that a disruptive power sector transition was likely suggested that technical, economic and political drivers of disruption through digitisation and decentralisation would overwhelm continuity-based logics and interests.

However, most respondents expected that the UK power sector transition would be continuity-based in key respects, with large energy supply companies unlikely to be wholly displaced by 2040, and large scale renewables being the single most important contributor to power sector transition. Demand-side management and response, and smart (digitised) electricity networks were also expected to make important contributions, enabling the greater diffusion of renewables. There were much lower expectations about the role of nuclear power and CCS over this period.

Transport sector

There was an overwhelming consensus among respondents that the UK transport transition to 2040 would be dominated by technological substitution, with electric vehicles making the dominant contribution to changes in personal transport. A few participants cautioned against taking this for granted, as there is still some way to go before electric vehicles can be affordably adopted and integrated in the wider energy system.

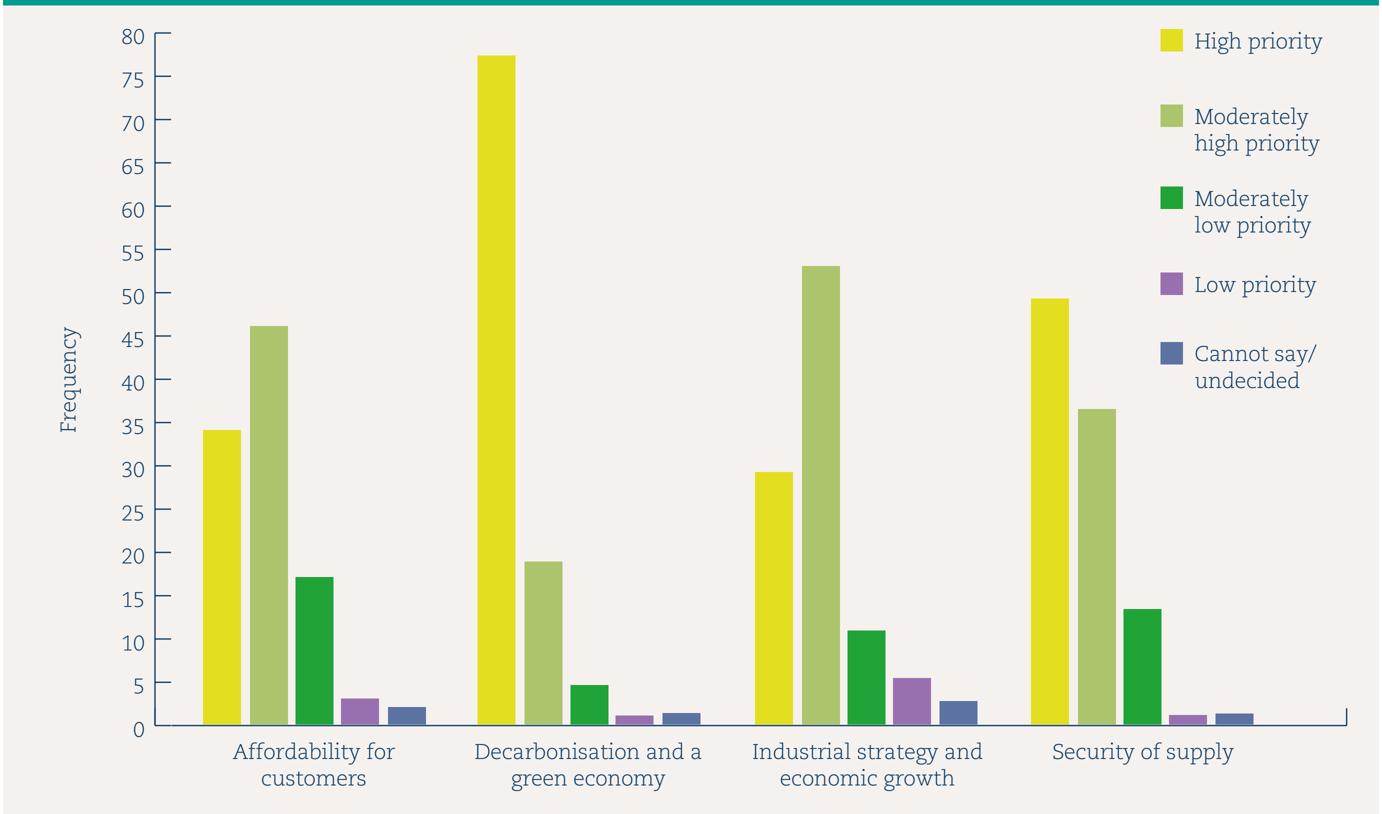
There was much less agreement about the impact of social and behavioural changes. Many respondents were sceptical that greater use of public transport, cycling and walking would command enough policy support to contribute to change, and some noted that behaviour change could lead to increased demand and carbon emissions from transport. However, more than for power and heat, the transport transition was seen as being shaped by issues and trends beyond energy, with some suggestion that changing patterns of ownership – especially among younger people living in urban areas – and local air quality concerns could lead to more dramatic changes in transport related social norms, emissions and policy.

Policy and innovation priorities

In terms of high level UK energy policy drivers, 'decarbonisation and a green economy' emerged as the single most important priority for respondents, followed by energy security, affordability and industrial strategy concerns (Figure 8). While many participants believed that all four priorities should be addressed for a successful low carbon transition, some highlighted tensions between decarbonisation and affordability, and argued that affordability concerns should be focused on the most vulnerable consumers via general welfare policy. Similarly, a small number of participants saw a priority on industrial strategy as problematic, either because it may come into tension with decarbonisation, or because governments should not intervene in the market in this way.

The most important policy measure for meeting these high level priorities was seen as supporting energy demand reduction. Other priorities were using the competitive market to support low carbon technology deployment, supporting greater citizen involvement in regional and local planning and promoting the digitisation of energy systems.

Figure 8: The UK's high level energy policy priorities to 2040



There was much less agreement in some other areas: regulating or capping energy prices, public ownership of energy infrastructure and organisations, and striving for national energy independence and avoiding import dependence (Figure 9).

The results also suggest distinctive energy innovation agendas over shorter and longer terms. Up to 2040, the emphasis is on extending and deepening current trends toward renewables and electrification of the wider energy system (with a key role for innovation in energy storage technologies), and on technologies for improved buildings energy efficiency. After 2040, priorities shifted to support decarbonisation in more 'difficult to change' parts of the economy, and this was seen by many as requiring the commercialisation of large scale technologies such as CCS and low carbon hydrogen. Table 1 brings together data from different parts of the survey to identify innovations expected to make the biggest contributions to UK energy system change up to 2040.

Finally, most respondents saw the UK's academic energy research community as basically sound, in terms of its expertise and ability to respond to emerging challenges. However, there was less agreement on whether the academic research base was too dispersed and fragmented, with many calling for greater integration and coherence (perhaps surprisingly, this view was strongest among academic researchers). Most participants also supported calls for the greater involvement of both business and policymakers in academic energy research.

Figure 9: Policy priority areas

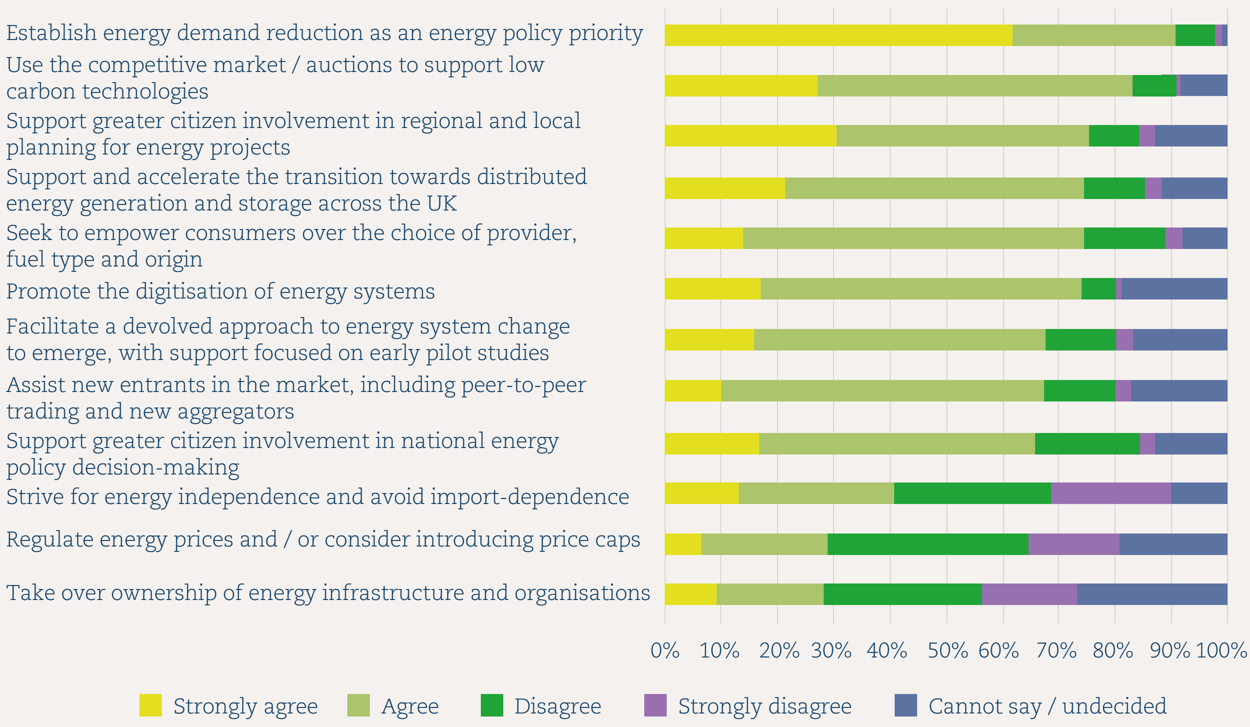


Table 1: Most important contributors to UK energy system transition up to 2040, all sectors		
Rank	Innovation	% of participants agreeing
1	Electric vehicles	93
2	Improvements in building fabric	84
3	Large scale renewables	80
4	Demand-side management and response	62
5	Hybrid electric vehicles	56
6	Buildings-scale heat pump technology	52
7	Digitisation and smart grids	44
8	Low emissions zones	44
9	Demand-side management and response	42
10	Local / municipal heat networks and energy centres	42

Understanding stakeholder differences

There are a number of explanations for the widespread differences in expectation and preference seen in the survey results. Different stakeholders interpreted the survey propositions in different ways: for example, some focused on emerging changes – arguing that niche innovations would spread and carry wide influence, while others questioned their significance and scalability for the system as a whole. There were also varied understandings of energy system stability and 'tipping points', in terms of likely responses to pressures for change. For those anticipating disruptive change, current arrangements tend to be seen as fragile and vulnerable, whereas those who see change mainly in terms of a continuity-led logic see the current system as relatively resilient and adaptable.

One way respondents made their assessments of likelihood was through an interplay between an 'internal' energy system imperative, with 'external' conditioning by policy and regulatory frameworks. For those who saw change in this way, it is only when there is both an internal imperative for disruption ***and*** a policy willingness to enable it, that a disruptive transition is likely. In other cases – either where there is no logic of disruption or where this logic is likely to be frustrated by policy resistance – then a continuity-based transition was considered more likely. Those who saw an imperative for disruption often identified a role for policy in confronting resistance and unleashing the forces of disruptive change. Yet, for many issues there was no agreement on internal imperatives, external conditioning or their likely interaction, and other respondents framed the problem differently, as a more fluid co-evolution of technology, economics, behaviour, regulation and policy.

Respondents also differed on which bodies of evidence and experience were most relevant to a given issue. Indeed, respondents' comments only rarely mentioned explicit sources of evidence – even when invited to – and more typically referenced specific recent niche developments or trends to explain their answers. The absence of an agreed evidence base on many issues, and the limited instances of changing views between survey rounds, suggests that stakeholders' responses reflect rather durable values and 'worldviews' which may be unresponsive to the views of others, or new and contradictory evidence.

Conclusions and implications

The survey results capture a significant body of expertise and knowledge about the current and future state of the UK energy system. While there was consensus on some issues, the disagreement seen in many areas – across the overall system, different sectors and specific innovations – suggests the need to consider both disruptive and continuity-based developments shaping the UK's energy transition. The results also show the need for a mix of policy priorities, some of which are more disruptive (such as promoting distributed energy and greater citizen involvement in regional and local policy), while others – though they also have disruptive elements – reflect more continuity-based responses (such as upgrading building fabric and supporting large scale renewables).

In areas of high expert and stakeholder consensus, an appropriate role for policy is to support accelerated development and deployment. In areas of low consensus, policy should address the need for a stronger evidence base, through pilot studies, larger-scale demonstrations and evidence reviews. Although most stakeholders expect large contributions to the UK energy transition over the next two decades from a few key areas, (large scale renewables, improved buildings efficiency and electric vehicles) these expectations are based largely on the significant perceived potential in these areas, rather than positive assessments of the effectiveness of current policies. Indeed, there are concerns about stalled progress and looming policy shortfalls in some critical areas.

Disparities between respondents' preferred and expected futures also suggest some policy priorities. For example, while most participants supported greater public involvement in local and regional energy policy-making processes, there was less consensus that this would happen in practice – suggesting the need for more policy support. Similarly, while a majority of respondents agreed with policies to promote distributed energy, other responses pointed to uncertainty about the implications of distributed energy for energy security and flexibility, highlighting the need for a stronger evidence base. Finally, the unavailability of carbon capture and storage was an area of 'high likelihood' and 'high significance' for the UK energy transition overall, implying the need for stronger policy support.

The survey findings also present a challenge to evidence-based policymaking. While more and better evidence can help reduce uncertainty and dissensus in some areas, in other areas stakeholder differences reflect deeply held interests and values. The tendency for respondents to reinforce rather than modify their views about the future, and to make only limited reference to published evidence or the views of other respondents, implies a need for policymakers to consult widely and openly – with incumbents, new entrants and independent analysts. Energy scenario developers should give more explicit recognition of value differences among experts and stakeholders to facilitate a robust comparison of alternative solutions reflecting different values.

There are merits and pitfalls in fostering disruption or repurposing existing assets – the case for either depends greatly on the specifics of the problem at hand. Rather than being in thrall to a single logic of disruption or continuity, policymakers should independently and transparently consider the full range of different solutions when addressing energy policy challenges, drawing on a wide range of evidence and expertise. Any one-sided broad commitment to a disruptive or continuity-led energy transition logic is likely to reinforce old blind spots or create new ones, undermining overall policy effectiveness.

The research reported here was conducted as part of the work programmes of the UK Energy Research Centre and ClimateXChange. The report conclusions and recommendations reflect the authors' views, rather than their organisations or funders.

This briefing paper is based on the findings of a longer working paper, which is available on request.

For further information, please contact:
Dr Mark Winskel
Dr Michael Kattirtzi

Science, Technology and Innovation Studies Group
School of Social and Political Science
University of Edinburgh

email:
mark.winskel@ed.ac.uk
michael.kattirtzi@ed.ac.uk

Acknowledgements

The authors thank the many people from energy research, policy, business and civil society organisations who kindly participated in the research reported here. The research was supported by the UKERC Disruption and Continuity Project Advisory Group, ClimateXChange and the Scottish Government and also the broader UKERC research community, who provided feedback on pilot versions of the survey design, and presentations of interim findings.

The research reported here was presented in interim form at a number of conferences and workshops in 2018, including: a dedicated UKERC workshop in London (March 2018), the ***All-Energy*** conference in Glasgow (May 2018), the ***International Sustainability Transitions Conference*** at the University of Manchester (June 2018), a UKERC and ClimateXChange roundtable meeting with the Scottish Government in Glasgow (June 2018), the British Institute of Energy Economics biannual conference at the University of Oxford (September 2018) and the Scenarios 2018 Planning and Foresight conference at the University Warwick (December 2018).

About ClimateXChange

ClimateXChange (CXC) is Scotland's Centre of Expertise on Climate Change, providing independent advice, research and analysis to support the Scottish Government as it develops and implements policies on adapting to the changing climate and the transition to a low carbon society. CXC is funded by the Scottish Government.

For information please visit: www.climatexchange.org.uk

Follow CXC on Twitter @ClimateXChange

About UKERC

The UK Energy Research Centre (UKERC) carries out world-class research into sustainable future energy systems. It is a focal point of UK energy research and a gateway between the UK and the international energy research communities. UKERC's whole systems research informs UK policy development and research strategy.

UKERC is funded by UK Research and Innovation Energy Programme.

For information please visit: www.ukerc.ac.uk

Follow UKERC on Twitter @UKERCHQ