UKERC
UK Energy Research Centre

UKERC Technology and Policy Assessment

2019-2020 Topics consultation summary

Rob Gross (Imperial College London)
Richard Hanna (Imperial College London)
Phil Heptonstall (Imperial College London)

April 2020

Introduction to UKERC

The UK Energy Research Centre (UKERC) carries out world-class, interdisciplinary 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.

Our whole systems research informs UK policy development and research strategy.

UKERC is funded by the UK Research and Innovation, Energy Programme.

Technology and Policy Assessment (TPA) within UKERC

The Technology and Policy Assessment (TPA) team was set up to inform decision-making processes and address key controversies in the energy field. It aims to provide authoritative and accessible reports that set very high standards for rigour and transparency. Subjects are chosen after extensive consultation with energy sector stakeholders.

The TPA has been part of UKERC since the centre was established in 2004 and is now in its fourth phase, which started in 2019. The primary objective of the TPA is to provide a thorough review of the current state of knowledge through systematic reviews of literature, supplemented by primary research and wider stakeholder engagement where required.

Contents

The TPA topics consultation

Background and purpose of this document

The UK Energy Research Centre's TPA team has consulted extensively over prospective review topics since it was first established in 2004, and the TPA Director and team have experimented with a variety of approaches to such consultation. In previous phases of UKERC the TPA team have run stakeholder consultation events in London, Edinburgh and Cardiff. These consultations have also included wide-ranging discussion of the role and nature of evidence reviews and of UKERC/academia in contributing to policy debates.

As UKERC begins Phase 4 of its funding (running until 2024), the TPA team has conducted a new round of consultations over future projects. Consultation workshops have been held in Edinburgh, Cardiff, Belfast, and London.

The purpose of this document is to consolidate those topics and areas of interest that emerged from the consultation workshops. The aim is to establish the major topic groupings and the extent of support for those topic areas across the consultations. The UKERC TPA team will review and reflect upon these consolidated topic groupings when deciding which topic areas may be amenable to evidence review (and if so how a tractable question might be framed). The UKERC Director will decide which topics to take forward, taking into account the topic selection criteria (see below) and the advice of the other UKERC Co-Directors and the UKERC Advisory Board.

The Appendix provides the full notes and attendee list for each workshop. At each workshop (other than Cardiff), attendees were split into a number of smaller groups and each group was asked to generate, and if possible prioritise, a list of potential topics for future UKERC TPA projects, bearing in mind the TPA team's topic selection criteria. The workshop notes vary in format between groups, reflecting the differing approaches and discussions taken by each group, and the degree of consensus within groups. At each workshop, and in each group within each workshop, there were wide-ranging discussions covering many topics and areas of interest. Some of these may lend themselves to an evidence review approach and others may not, or may be more appropriate to projects for consideration under the UKERC Flexible Funding. Note that all the workshops were held under Chatham House rules so no topics, observations, or comments are attributed to individual attendees.

Priority topics/areas of interest

Table 1 below summarises the priority topics/ areas of interest that were identified by the groups within each workshop. In some instances there is a degree of duplication of topics/areas within a consultation event, and this is a result of more than one group at that event identifying the same or similar topic as a priority. Note that the ordering of topics in this table within each consultation workshop is not material and does not indicate any further degree of prioritisation.

Table 1: Summary of priority topics/areas identified at each consultation event

Edinburgh
Net zero conceptualisation
Public acceptance
Decentralisation and local energy
Distribution – who pays for the transition?
Local approaches
Building energy services
Security of supply/cross-sector resilience
Public Engagement
Difficulty of decarbonisation/role of offsetting
Net zero impact on households
Improving building EPCs
Low carbon economy and jobs
Energy/emissions modelling for net zero
CCS – credibility and success factors
Local/community energy benefits
Cardiff
Role of local authorities and governance
Local energy modelling
Skills and supply chain
Marine energy
Energy regulation/Ofgem role and approach
Markets vs place-based approaches
Public attitudes to climate change and net zero
Industrial decarbonisation
Belfast
Business models for demonstration projects
Achieving net zero
Local authorities and local area energy planning
Consumer engagement
Heat demand mapping

Retrofit vs rebuild
Local area energy systems
Governance and capability
Heat strategy and oil replacement
Energy, food and waste (circular economy)
Social acceptance and renewables
Heating, health and fuel poverty
Waste water and community heating
Policy impact on rural populations
Natural gas and net zero
Retrofit policy/governance
London
Hydrogen
Local energy
Co-benefits of net zero
Just transitions
Impact on energy sector of decarbonising other sectors
Domestic energy efficiency policy effectiveness

Table 2 below organises the priority topics/areas listed above into major topic groupings (column 1), together with a count (column 2) of how many times a topic in that major grouping appeared in the list above. This gives an indication of the degree of support amongst workshop attendees for topics in that major grouping. The major topic groups are listed in descending order so that, on this measure, the most 'popular' topic group appears at the top of the table. As might be expected, several of the priority topics/areas were linked by workshop attendees to targets for reducing CO_2 emissions to net zero. In practice, this is the underlying context for many of the priority topics/areas (whether explicitly stated or not), so the TPA team have not created a net zero major topic grouping since arguably most of the topics/areas would fall into such a grouping.

As the notes in the Appendix show, workshop attendees often also identified a set of other topics which were of significant potential interest but which were not within the top priorities lists. The count of how many times these secondary topics also overlapped with the major groupings is shown in column 3. The final column (4) in Table 2 identifies whether a topic grouping was also identified as an area of interest in the internal consultation undertaken at the 2019 UKERC Annual Assembly.

Table 2: Grouped priority topics/areas

(1) Topic/areas	(2) Count (priorities)	(3) Count (secondary priorities)	(4) UKERC 2019 AA?
Heat Heat demand mapping; Heat strategy and oil replacement; Heating, health and fuel poverty; Waste water and community heating; Natural gas and net zero	5	7	No
Local energy Local energy; Local energy modelling; Local area energy systems; Decentralisation and local energy; Local/community energy benefits	5	5	Yes
Local governance Local authorities and local area energy planning; Role of local authorities and governance; Local approaches; Markets vs place-based approaches; Policy impact on rural populations	5	4	Yes
Skills and jobs Skills and supply chain; Low carbon economy and jobs; Industrial decarbonisation	3	6	Yes
Engagement Consumer engagement; Public Engagement; Net zero impact on households	3	3	Yes
Public attitudes and acceptance Public attitudes to climate change and net zero; Social acceptance and renewables; Public acceptance	3	3	Yes

Retrofit policy/governance; Retrofit vs rebuild	2	4	No
Just transitions; Distribution – who pays for the transition?	2	2	Yes
Conceptualisation of net zero; Achieving net zero	2	1	No
Building energy services; Improving building EPCs	2	0	No
Hydrogen	1	4	Yes
Energy regulation/Ofgem role and approach	1	3	No
Governance and capability (national)	1	3	No
Difficulty of decarbonisation/role of offsetting	1	2	Yes
Domestic energy efficiency policy effectiveness	1	2	Yes
Security of supply/cross-sector resilience	1	2	No
CCS – credibility and success factors	1	2	No
Energy, food and waste (circular economy)	1	1	Yes
Energy/emissions modelling for net zero	1	1	No
Marine energy	1	1	No
Impact on energy sector of decarbonising	1	0	No

other sectors			
Business models for demonstration projects	1	0	No
Co-benefits of net zero	1	0	No

TPA topic selection criteria

The TPA team have five general criteria against which prospective TPA research topics are assessed:

1. Does the question reflect the concerns of users?
2. Is the question relevant to current energy policy debate and/or the objectives of the UKERC and UK energy policy?
3. Are there important areas of conflict or confusion that a TPA assessment could help overcome?
4. Can the question be made sufficiently concise as to allow it to be addressed within the timeframe and resource limits of the TPA?
5. Is the question amenable to a synthesis assessment based on existing evidence? (For example, is the question sufficiently tightly defined? Is an adequate evidence base both available and accessible?)

Mapping the most popular topics against the TPA selection criteria

This section discusses the six most popular topic areas identified in Table 2 (i.e. those above the grey line) in relation to the TPA selection criteria and the wider context. Illustrative questions are included for each of these topic areas, but note that these are not intended to be prescriptive.

Heat
This topic area included heat demand mapping, heat strategy and oil replacement, heating, health and fuel poverty, natural gas and net zero, and waste water and community heating. All these were identified as particular areas of interest by the Belfast consultation attendees. More generally, the wide range of issues around heat and heating were also identified as areas of interest by both the Edinburgh and London consultations attendees. In this respect, it is clear that the general topic area of heat is of concern to stakeholders. The comments from consultation attendees suggest that it is relevant to current energy debates focussed on decarbonisation of heat, and the particular location-specific challenges that this poses, and that the question as to what are the most appropriate solutions is far from settled. The Department for Business,

Energy and Industrial Strategy also have a current consultation on ‘Heat networks: building a market framework’, that is open until May 2020. The TPA team also addressed the issue of heat decarbonisation policy in phase 3 of UKERC. However, the heterogeneous nature of the issues may present a challenge in devising a research question that is both amenable to the TPA approach and that fits with the resources available. In addition, there is significant activity in the area of heat in other UKERC phase 4 research programmes, which may either preclude TPA work in this area, or alternatively offer an opportunity for cross-programme collaboration.

Illustrative questions:

- Which approaches could work most effectively to deliver a large-scale rollout of low-carbon heat whilst achieving an equitable sharing of costs?
- Which policies are likely to most effectively address low-carbon heating while improving thermal comfort-related living conditions, and reducing fuel poverty?

Local energy

This topic area included decentralisation and local energy, and local/community energy benefits, both of which were identified by Edinburgh attendees. Local energy modelling was identified by Cardiff attendees, and local area energy systems was identified by Belfast attendees, with the general issue of local energy being raised by London attendees. The local dimensions of energy were also more generally raised across the Edinburgh, Belfast, London, and the internal UKERC consultation exercise. Taken together, this suggests that the localised issues and challenges raised by energy decarbonisation are of broad interest to our stakeholders. Further investigation will be required to establish the extent to which this is reflected in live policy debates at the national level, and to discern whether there is a significant degree of debate or confusion in this area which is amenable to a systematic review of the available evidence. A careful assessment would therefore be required before the TPA team were to take something in this area forward.

Illustrative questions:

- How can more localised energy systems contribute to decarbonisation?
- How can the benefits of low-carbon industries be captured more locally?

Local governance

This topic area included local approaches and the policy impact on rural populations, both identified by Edinburgh attendees. The role of local authorities and governance, and comparing markets vs place-based approaches were both identified by Cardiff attendees, with the issue of local authorities and local area energy planning being identified by Belfast attendees. Issues related to local governance were also identified more generally at the Edinburgh and Belfast consultation, and to a lesser extent by London attendees. This suggests that this topic area has broad support amongst our stakeholders. However, as with the local energy topic area discussed above, further investigation will be required to establish the extent to which this is reflected in live policy debates at the national level. Some consultation attendees (but by no means all) raised a concern that formulating a tractable question in this topic area may be difficult. It should be noted that this topic was identified as priority in the UKERC Flexible Fund consultations, so it is possible that work in this area is taken forward through that route.

Illustrative questions:

- What is the international evidence for the role of local authorities in decarbonisation?
- How can local authorities be empowered to deliver decarbonisation, and what are the most appropriate areas for local authority governance (relative to national government)?

Skills and jobs

This topic area included skills and supply chain, and industrial decarbonisation (both raised by Cardiff attendees) and low carbon economy and jobs (raised by Edinburgh attendees). This general topic area also secured relatively wide interest amongst secondary priorities (by London and Edinburgh attendees in particular) and was also raised at the UKERC internal consultation. In respect of policy relevance it has clear links to the current UK Government Clean Growth Strategy aspiration and plans. Low carbon job creation could also be of high relevance to post-COVID19 recovery plans. The UKERC TPA team have carried out previous work in this topic area, in particular examining the evidence for green job creation.

Illustrative questions:

- What lessons can be learned from the impact of previous energy transitions on jobs and supply chain development?
- Update previous UKERC TPA work on ‘green jobs’ in the context of net zero and just transitions.

Engagement

This topic area included public engagement, and the impact of net zero on households (focused on the extent to which the public are engaged with this objective), with both of these topic areas identified by Edinburgh attendees. The topic area of consumer engagement was identified by Belfast attendees. This topic grouping was also discussed more generally by the Edinburgh attendees, to some extent by attendees at the London consultation, and also during the internal UKERC consultation exercise. There was therefore clearly some interest in this topic area but support was not as broad as for the topic areas discussed above. The question as to what extent the public and consumers are engaged with the decarbonisation programme, and in particular the relatively recent focus on achieving net zero emissions, is one that is perhaps of increasing focus for policymakers. However, net zero targets are a recent development which raises the question as to whether there is a sufficiently deep evidence base available to facilitate a useful review. There is also the question as to how much overlap there is between this topic grouping and public attitudes and acceptance (see below).

Illustrative questions:

- What is the historical evidence for the importance of public engagement in large-scale energy transitions?
- How is the role of citizens assemblies in the energy transition best evaluated, and what are the success factors?

Public attitudes and acceptance
This topic area included public attitudes to climate change and net zero (raised by Cardiff attendees, social acceptance and renewables (raised by Belfast attendees), and public acceptance (of low-carbon programmes, raised by Edinburgh attendees). This topic grouping was also discussed more generally by attendees at all the consultation events other than London, and was raised as an area of interest at the UKERC internal consultation. The topic area does therefore seem to have relatively wide support across many of our stakeholders. As with the engagement topic grouping discussed above, it may be that the recent focus on achieving net zero emissions will increase policymakers focus in this area. However, the Societal Engagement Observatory programme of phase 4 of UKERC will be taking forward work in this area so any TPA project would need to be clear as to how it would add value, or compliment, that programme's work. This might, for example, be in the form of a joint project, drawing on the Societal Engagement Observatory programme team's expertise and knowledge of the evidence base in this area.

Illustrative questions:

- To what extent is public acceptance of new technologies (e.g. CCS, DAC, H_2) essential to achieving net zero?
- How has the public acceptance of climate change and the required energy transition changed in recent years, and to what extent has this varied by countries and/or regions?

Next steps

The next step is for the UKERC Director and Co-Directors to consider these priority areas, together with any advice from the UKERC Advisory Board, and decide which could be taken forward as the first TPA projects in phase 4 of UKERC. It should be recognised that eventual TPA projects may address research questions which cut across these areas if the UKERC management team take the view that that is the most effective way of formulating tractable, policy-relevant research questions. Projects may also incorporate some elements of the topics which were of potential interest but which were not within the top priorities lists.

Appendix: Notes and attendee lists from the consultation workshops

Edinburgh – November 2019

Attendees were split into four groups and each group was asked to generate, and if possible prioritise, a list of potential topics for future UKERC TPA projects.

Within each group there were wide-ranging discussions covering many topics and areas of interest. The notes from each group are shown below in Boxes 1 to 4. These notes vary in format between groups, reflecting the differing approaches and discussions taken by each group, and the degree of consensus within groups. Attendees are listed in Table 3.

Box 1: Notes from Edinburgh Group 1

Generic concern: any of the TPA topics need to come back to policy: there are big implications for how we phrase the topics so that they are applicable to policy. The headline language needs to relate to headline targets.

TPA topic ideas initial discussion:

Practical application of ideas/technologies to local level. The context here is that it is very difficult to take national-level data to apply at the local level – data are not in the right format. Decisions are harmed by not being able to use best data that exists – some have experienced situations in which no one could provide model for the task that local authority needed to achieve. Interested in what is being done, what mechanisms exist to make data usable at different levels? Leads to this research question: How can different understanding of data modelling/outputs be provided in a usable way for each level of the system? This could perhaps be phrased differently e.g. What is the toolkit that is needed for local authorities? What is missing?

Local content of energy systems. There is a perception that a lot of the firms providing technologies are not local. Leads to this research question: How much design/development/manufacturing has local content, and how can we encourage it? There is the quantitative question (measuring) and a question of enabling (how to encourage local use). Perhaps related to capturing local spending. Need to recognise that there are political implications. Could include all of the components of energy technology (materials, etc.). Strathclyde colleagues are working on this topic (jobs creation, etc.). Qualitative components that could be evaluated include job skills, quality of jobs, etc.

Offsetting. The context here is that in the move to net zero, there is a lot of talk about offsetting, peatland restoration, growing trees, etc. A worry is that we will need offsetting in Scotland due to impacts of certain industries, but

theoretically you could offset everything. Leads to this research question: What is the physical limitation of offsetting capacity (leaving aside economics)? Is it based on physical land limitations? What is the scale (UK scale or Scotland?). Recognised that the CCC calls on Scotland to meet targets five years earlier because of the potential for offsetting. Other factors to consider include carbon opportunity cost, changing diets (CCC recommendations in net zero report suggest significant reduction in meat consumption). Farmers are concerned about this because they are currently involved in the EU production model (this may or may not change). Scotland's dairy and meat industry is argued to be carbon neutral (by NFU), but this misses the argument about the carbon opportunity of growing trees on that land. There is competition between resource generation and storage. It might be better to describe offsetting as carbon sequestration, because that way it doesn't let people off the hook for thinking they don't need to offset (behavioural psychology issue). Maybe a risk that this topic might not be directly related to energy for the UKERC context.

Local versus centralized energy systems. The context here is the movement of energy system strategy toward emphasising local energy. This is different from previous approaches emphasising centralisation. Leads to the following research questions: How can local communities coordinate with each other? Is this possible, or do we risk shifting to the opposite extreme of focusing only on local energy systems? Can we identify what areas need to be shifted from central government planning and can benefit more from local strategy? Perhaps think about resilience in local energy systems? i.e. what systems will work in some areas and not in others, based on legacy of existing energy systems.

Local energy systems. The context here is that we have a Scottish Energy Strategy (Dec 2017) based on a whole systems approach, covering all of the sectors and considering them as a whole system. One of the core principles is local energy systems but it's not clear that policy shows a clear understanding of what local energy systems mean. Does it mean the development of local energy democracies where communities can have a democratic stake in the local energy system? Are we going to see EV charging points continue in the hands of big oil companies, or is that going to become more of a locally-based resource? Is there a shift coming in the way energy is viewed and the way that communities have a stake? Given that a lot of renewable capacity has increased in the past 10-15 years, are there policy mechanisms and funding mechanisms in place to support this local shift?

It is clear from the ideas described above that there is a need for local area related questions, spanning socioeconomic, data, physical infrastructure questions. It was recognised that it is very difficult to frame a policy question on this topic. The Orkney example is possibly instructive, but can it be scaled up for other areas? In summary, the questions relate to: What is the evidence that local approaches work, and work better? Better for whom? For what part of the energy system? Need to recognise that it is ill-advised to presuppose that local approach is best, and centralised is bad.

TPA topic ideas subsequent discussion, focussed on need for clearly articulated questions for an evidence review.

Scale of different interventions is a challenge. Research question: Is there evidence of there being multiple interventions on a building (e.g. installing solar panels, etc.) at the same time, and what are the cost-benefits? Is it cheaper to do all at once? What is the cost of a collaborative strategy?

Security of supply. Has this already been evaluated? (TPA has done things on variability and flexibility of energy systems). Research question: How secure are cross-system energy approaches? Can low-energy electricity systems work? (Scotland is looking to close two nuclear plants – are we prepared for this?) Concern that the question might not be suitable for a TPA topic because there may be a lack of evidence, though modelling studies could be reviewed, or it might be possible to look at case studies.

Effectiveness of citizens' assemblies for energy transitions. Need to recognise the doubts regarding the evidence base, but is there evidence of other means of effective citizen engagement? How would we evaluate success? Perhaps through consensus? To what extent do these engagements fundamentally change the way that people view their resource consumption? To what extent are people prepared to have their heating systems disrupted? Do people need their information level brought up, given propositions, to then evaluate their values/preferences? Demand reduction policies: what are local communities' relationship with their energy choices? Probably not enough empirical research on this yet for an evidence review.

Decarbonisation. The context here is that decarbonisation of all sectors is fundamental to the Climate Change Plan. We need to do as far as we can but how can that happen without job losses or subsidy? Energy input will still be required, e.g. imported gas required to run various firms. Need to recognise that some work has been done on industrial emissions, and there is an industrial decarbonisation project in UKERC4. Work in this area needs to not just use data of industrial users but needs to be done in collaboration with industrial users. There is a broader question of what service we want to deliver for society and what systems produce those outputs? There is a need to get beyond the trap of each sector arguing their energy source is the solution.

Direct air capture. Research question: Will direct air capture work? UKERC has already done work on direct air capture. Perhaps a comparative assessment of direct air capture to other options?

Summary of discussion (consolidating main ideas)

- Local approaches, stemming from Scottish Government increasing focus on local. There are numerous questions under this heading.
- Building energy services, multiple interventions
- Security of supply (cross-sector resilience)
- Public engagement activities
- Difficulty of decarbonisation / role of offsetting

Reflection on these suggestions:

- Local approaches might be difficult for UKERC TPA to convert into a practical project – needs concrete question(s).
- Something technical on low inertia (supply security) is tractable.
- Something on public engagement activities, but unsure about what should be done.
- Possibility of working with CXC for the decarbonisation / offsetting question.
- UKERC in the past has looked at energy efficiency but could revisit, though some stakeholders more interested in the logistical questions of how to implement interventions. Are area-based schemes fit for purpose? A project on this question might be more appropriate to an application for UKERC flexible funding rather than a TPA project, because of the need to get policy people and planners involved.

Box 2: Notes from Edinburgh Group 2

TPA topics ideas initial areas of discussion:

Hybrid renewable systems: wave and wind. Focussing on their effect on a more stable energy output.

Building–up expertise for low carbon transitions. Danish wind example: achieving economic growth and low carbon technologies.

Energy systems integration. Gas and electricity networks: wider benefits of integration.

Accounting of emissions. Local authorities often have different targets to wider regions, possibility of double counting between local and national levels. Local authorities often have achieved targets via national policy e.g. decarbonisation of electricity.

Decentralised energy for net zero. Benefits of localisation, integrated heat, storage and digitalisation, offering new kinds of flexibility and the societal benefits of decentralisation. What sources of renewable heat are available in different local areas? Historically, the UK has backed away from decentralised energy.

Moving away from 'new public management' (NPM). Suggestion that NPM paralyses innovation (target setting and 'least cost' options are prevalent in Scottish Government) and moving away from it may facilitate getting to net zero.

Capturing value from low carbon innovation. We are good at inventing stuff and bad at making it – need more understanding of innovation chains.

Harmonisation/definition. What is net zero? A stepping stone to net negative? How do we account for offshore emissions i.e. the importing of high carbon goods? Key issue is that there is no clear definition of what net zero is.

Local policy effectiveness. Projects are often top down; there is a lack of integration of the people that will use the systems. How do we capture evidence from the grassroots and evidence of bottom up success, for community energy transitions?

Customer acceptability. We want to put the customer at the centre of things, but how do we know whether they are accepting of the changes taking place?

Modelling policy. Do we have robust models for energy policy? Do we know what that means?

Distribution of impacts. Who is going to pay for getting to net zero? Political and social acceptability: should the transition be socially progressive?

National delivery models. How is energy governed in different countries? What is effective: arms-length energy agencies, advisory groups etc.?

Distributional issue of how heat is paid for in the future. Low carbon heat is likely to have higher upfront costs and possibly to have higher operational costs. If we are to achieve fuel poverty targets, those that are in fuel poverty must pay less for future (low carbon) heat. What system of payment allows for this? Possibly a review relating to distribution of payments for utility services (drawing on international and historical examples)?

General points raised (may not relate specifically to potential TPA topics)

- Public acceptability has come up repeatedly.
- Which types of government institutions are effective?
- We need a clear idea of what net zero means.
- What emissions should be included in accounting e.g. embedded and overseas emissions.
- It is unlikely that we will get a consensus on net zero in the short to medium term: divided society, deeply uneven impacts of net zero.
- Discussion of net zero needs to include the public … it is already a good thing to do this in the public sphere, as a means of engaging the public with what changes are coming.
- Discourse around net zero has made everything real, but we should be having a conversation about net zero – but how is this changed into an evidence review topic: review of definitions of net zero?
- BEIS and CCC calculate emissions in different ways. BEIS say we are doing well, CCC say that we are underperforming.
- Building-up expertise and capturing benefit from energy innovation.
- Value systems: what we count is very significant … how much public money has gone in to supposedly private entrepreneurial activity?
- Local authorities tend to focus on transport and waste, but should they also consider land use?

Key themes that emerged

1. Net zero conceptualisation
2. Public acceptance
3. Decentralisation and local energy
4. Distribution: who pays for the transition?

Box 3: Notes from Edinburgh Group 3

Agreed priority areas

Households

What does net zero mean for the individual? What would our lifestyles look like in a net zero UK? Context here is being able to communicate the change, highlighting potential co-benefits in some areas etc.

Economics impacts for householders associated with net zero i.e. where costs may fall, where costs may rise, net effect etc. Context here is the opportunity to build on work already done that highlights that things like mobility costs may fall associated with reduced costs of EV operation, but potential heating costs could increase etc.

An evidence review could focus on which approaches to providing consumer advice associated with changes aimed at cutting emissions work most effectively (for households)? Context here is the varying approaches taken to date: UK and Scottish governments support different approaches, and there are likely to be other approaches elsewhere. What can we learn from reviews of effectiveness/which are likely to be most compatible with scale of transformation required?

Local/community energy. Review the benefits of local/community energy, understanding more about whether people would pay more for local low carbon energy, and if so, how much more? The context here is that there is some evidence that people are sympathetic/willing to pay a premium for local/community/low carbon energy, but it is not clear how significant this is, what are the caveats etc.

Developing new building Energy Performance Certificates (EPCs). What can we learn from approaches elsewhere; what would they look like/what should be included/how should they be verified etc.? Context here is that EPCs are due to be reviewed, a lot has changed since they were originally developed, so how do we use this opportunity to make them supportive/compatible with net zero ambition? How do other jurisdictions approach this?

Low carbon economy. Developing a better understanding of the scope and scale of jobs potential in a low carbon economy, the approaches aimed at best

securing/retaining these jobs, the development of necessary skill sets, and where can effort be focused/distinct opportunities to capture these jobs? Context here is that the scope and scale for green jobs is regularly referred to, but how robust is the associated evidence, what can we learn about how to secure/retain these jobs, are there specific opportunities e.g. in Scotland or UK in specific areas of supply chain etc., and what can we learn from other transitions elsewhere?

Energy/emissions modelling. Review how well our current modelling approaches e.g. TIMES are able to explore/identify pathways compatible with net zero/1.5 degrees. What are the challenges/uncertainties/constraints associated with current approaches? Context here is that policymakers rely on approaches like TIMES to inform the development of mitigation plans, but given the limitations/constraints, is the net zero/1.5 target throwing up further challenges for models to reconcile?

Carbon Capture and Storage/Use (CCS/CCU). Review of the evidence around the likelihood of success, costs and deployment timescales for CCS/CCU to inform the assessment of feasibility/likelihood/scale of deployment in the UK. Context here is that many net-zero pathways include significant emphasis on CCS (e.g. as BECCS) and there is a need to review the credibility of these assumptions, especially in regard to timescales of deployment.

Other Suggestions and areas of interest

- What are the methods and costs of achieving modal shift in transport?
- Use of energy in industry – how do we decarbonise? – with process heat as a priority.
- Progress in Green Hydrogen, at what stage can we get to viable cost?
- EV smart charging: does smart charging influence charging habits (evidence based)?
- Successful implementation of flexible demand.
- Low carbon aviation.
- Decision making under uncertainty.
- How to involve people in regional/local policy energy decision making (with a focus on the low carbon heat transition)?
- How to best get people to change behaviours in reducing carbon, what is the evidence for the best mechanisms to achieve change across low carbon i.e. do financial incentives work, does nudge approaches work? How do we get the climate change / low carbon message across to the public better; what forms of communication work best?
- What is the best financial model for transforming households to net zero?
- What are the fiscal measures that might support heat decarbonisation?
- What is ‘net zero carbon’ and how do we define it and evaluate it? What is current best practise in checking whether we are achieving net zero?
- How do we define affordability and cost?
- How does further potential devolution impact on the national future heating strategies i.e. repurposing of existing gas network?
- If we reduce/remove access to interconnectors what would happen?

How does Brexit impact on energy security?
- How do we get the best energy system balance (planning policy v price v best grid solution)?

Box 4: Notes from Edinburgh Group 4

Suggestions and areas of interest that emerged from discussion

- Identify success factors/failure in delivering upskilling/reskilling of the workforce.
- Assessing public acceptance of new technology including hydrogen, CCUS and low carbon aviation
- What are the experiences/success/failure factors in delivering disruptive policies or lifestyle changes?
- What are the experiences/success/failure factors in capturing economic benefits?
- Policy making under uncertainty.
- Evolution of the electricity grid in the transition to net zero, including decentralisation of generation, community based initiatives, and the evolution of the gas grid for local hydrogen.
- What can we learn from failure? We have a tendency to focus on successful outcomes – what about the failures?
- Study of community engagement around energy and net zero, including looking at the amount of 'bottom-up' community-led activity required for the transition, and comparison of communities at home and abroad.
- The development of co-production of goals and cooperation to lead to the transition.
- Hydrogen availability over time and different sources, and if limited, where best to use it: industry, housing or transport?
- Hierarchy of use for biomass.
- Consumption manufacturing future – horizon scan?
- EU SWAT Taxonomy
- Assessing how embedded climate change understanding and advice is across government portfolios, across various levels.
- What can devolved governments do in the absence of action from UK government?
- Carbon tax/border tax adjustment issues.
- Whole systems analysis – scenario beliefs – different modelling and pathways. How can research support integrated analysis and pathway development across the economy?
- Public investment mechanisms for low carbon infrastructure banks/regulated asset base etc.
- Active or passive citizens.
- CCS-free pathways.
- Net zero definition and the role of energy in net zero.
- The relationship between net zero and sustainability/emissions, but also the environment, land use competition and the circular economy.
- Passivhaus, net zero emission buildings, how do we communicate how

all of these relate (or not) to the public?

- Clarity of decarbonisation of operations in a sector. Oil and gas: clarity on the future/reconciling OGA/MER with decarbonisation.
- Local content for renewables (to some extent related to consumption/production based CO_2 emission calculations).
- Role of local authorities
- Hydrogen to different users (analogy to how we got it wrong in conveying the r for geothermal).
- CCS: international view on realistic uptake year on year.
- LCA best practices for transparent energy efficiency and net zero calculations.
- Low carbon network fund, post mortem.
- The problem with the deployment of solar under the last FIT scheme – 'skills for cowboys' – will the same be repeated for low carbon heat?
- How do we get the maximum economic impact for floating wind?
- Regional growth deals.
- Government department e.g. skills support for energy strategy
- Grid is evolving – are there regulatory barriers
- How is the gas grid evolving for hydrogen?
- Do we pay enough attention to failure? (look at academic versus commercial research)
- How do we get the community engaged in the net zero journey?
- Net Zero versus sustainable development goals.
- Fossil fuels – a plan for phase out?
- A plan for 2045 that works.
- Heat pumps – what are the barriers to update and what measures are needed to overcome them?
- Batteries versus fuel cells.
- Prosumer: reality or myth?
- Would an independent 'energy cabinet' have traction?
- Skills gaps
- What is the evidence for separating people from their own cars?
- What are the real level of the UK GHG emissions – including those offshore?
- A picture of land use by 2045
- The case for large scale hydro.
- Are regulatory barriers preventing the development of cross-sector energy policies? (via a review of electricity and gas regulation)
- Review of regional/local authority approaches to emissions accounting?
- Assessment and review of energy use behaviour change pilot/demo projects e.g. time-of-use tariffs. What worked best for domestic peak power and peak heat shift?

Table 3: Edinburgh attendees and affiliations

Andrew Aveyard	Business Development Manager for Energy Edinburgh Innovations, University of Edinburgh
Dan Barlow	Programme Manager, ClimateXChange
Keith Bell	ScottishPower Chair in Smart Grids, University of Strathclyde
Rebecca Bell	Policy & Research Officer, Scottish Centre for Carbon Capture & Storage (SCCS)
Laura Brown	Centre Manager, National Centre for Energy Systems Integration (CESI)
Mark Cassidy	Postgraduate Student, University of Glasgow
Graeme Dixon	Independent, ex-Scottish Government
Sandra Dorning	Postgraduate Student, University of Edinburgh
Gioia Falcone	Rankine Chair of Energy Engineering, University of Glasgow
Christina Francis	Research Associate, Local Energy Systems EPSRC EnergyREV consortium and University of Edinburgh
Rob Gross	Director, Centre for Energy Policy and Technology Imperial College London
Gareth Harrison	Bert Whittington Chair of Electrical Power Engineering, University of Edinburgh
Stuart Haszeldine	Professor of Carbon Capture and Storage, University of Edinburgh
Phil Heptonstall	Research Fellow, Centre for Environmental Policy, Imperial College London
David Jenkins	Assistant Professor, School of Energy, Geoscience, Infrastructure and Society, Heriot Watt University
Niall Kerr	Research Fellow / Analyst, University of Edinburgh and Scottish Government
Sasha Maguire	Head of Energy and Climate Change Analysis, Scottish Government
Hugh Muschamp	Programme Manager (Climate Change & Zero Waste), Resource Efficient Solutions
Alasdair Reid	Senior Researcher, Energy Climate Change and Land Reform, Scottish Parliament Information Centre
Fiona Riddoch	RSE Entrepreneur in Residence, Edinburgh Innovations, University of Edinburgh
Sarah Sheehy	Research Associate, National Centre for Energy Systems Integration (CESI)

Jamie Speirs	SGI Fellow in Energy Analysis and Policy, Sustainable Gas Institute, Imperial College London
Wei Sun	Research Associate, School of Engineering, University of Edinburgh
Camilla Thomson	Chancellors' Fellow, School of Engineering, University of Edinburgh
Noor van Velzen	Research Associate in Policy and Innovation Group, School of Engineering, University of Edinburgh
Elaine Waterson	Policy Manager, Scotland Energy Savings Trust
Jan Webb	Professor of Sociology of Organisations, School of Social and Political Science, University of Edinburgh
Stephen-Mark Williams	Executive Director, Energy Technology Partnership
Mark Winskel	Senior Lecturer, University of Edinburgh and Policy Director, ClimateXChange

Cardiff – November 2019

There was a wide-ranging plenary discussion covering many topics and areas of interest. The topics and/or areas of interest that appeared to have particular support amongst at least some of the attendees are listed in Box 5 below. Other topics or areas of interest that were mentioned or discussed at the meeting are listed in Box 6. In both tables, areas of interest are grouped by high level topic headings to aid readability. There is not a strict demarcation between Box 5 and Box 6 because there are potential linkages and overlap between areas. Attendees are listed in Table 4.

Box 5: Topics areas with particular support and/or interest amongst Cardiff attendees

Governance The role of local authorities in a multi-vector world. Need for much stronger local energy governance. Role of local authorities in energy infrastructure and energy engagement. Local area information and competencies - 22 small local authorities which may have limited capacity to carry out systematic research but they have evidence needs to support decision making. What are local authority competences and what level of resource is needed? Role of Local Enterprise Partnerships? How to improve engagement with citizens and citizens' assemblies and other forums. How to leverage the fact that Wales has a much stronger opportunity for joined up government than some other parts of UK (with possible exception of Scotland).
Modelling Focus on stronger local energy modelling, better understanding of local level modelling techniques and how to take these forward with people in local areas.
Skills Question about the skills base, and supply chain more widely, in the economy and whether Wales has the right skills in place e.g. experienced heat pump installers. Concern that skills provision tends to be demand driven rather than accounting for potential future needs.
Marine energy Welsh government (and Scottish government) see a future for marine energy, BEIS is generally sceptical. Can the technologies reduce in cost? Influence of Brexit on marine regulation – possible that it may reduce regulation and/or protections? Current marine protected areas could be lost

after Brexit. Welsh government believe some of these areas are still useable for marine renewables. Are there lessons to be learnt from e.g. Scottish research in the marine environment in respect of the environmental impacts of marine renewables? Is there a possibility to work with the UKERC Environment and Landscapes team (based at PML) in this area? Possibly a synthesis of research and evidence on marine energy and the environment in Scotland, and assessing which evidence is transferrable to a Welsh context? Important to take into account evidence such as how people value (or even know about) marine environments such as saltmarshes (e.g. has this changed in recent years?). Need to understand strong public disappointment re. tidal lagoon not going ahead, and what public perceptions might be re. other major coastal energy infrastructure projects. Possible need for synthesis of knowledge on major landscape changes. Concern that this may be better suited to primary research activities rather than evidence review.
Energy Regulation Current Ofgem regulations re. cost of capital, and provision for innovation spend do not seem sufficient to making an energy revolution happen (especially in the light of future demands for electric vehicle charging). Ofgem currently looking to fund as much as possible on a business as usual basis, where the allowed cost of capital is lower. How is funding allocated? What really is business as usual, and what really is riskier innovation? What is the balance between market-driven approaches to reduce costs, and planned, place-based strategies to enable decarbonisation? Perhaps scope for rapid evidence assessment? Can we look at it through an innovation systems lens?
Market vs place-based approaches Is the right approach a market-based or planned and place-based strategy for the transition to lower carbon energy? When are different methodological techniques (e.g. modelling) appropriate in supporting energy planning? How do we involve and bring along people in place-based strategies?
Public attitudes Reflecting the raised profile of climate change and climate emergency, has public perception changed significantly in the last two years? (links to the marine energy topic above) Is it more acceptable now than before to push climate change policies? Link to place (see above), how does this vary between regions and contexts? Is public opinion changing towards use of nuclear power as a low carbon technology, given the Extinction Rebellion campaign and possible changing attitudes towards climate change? Are we trying to understand changing attitudes, values, public acceptability or something that is more deeply embedded? Perhaps a high level view on public values and attitudes and their volatility, and how to go about securing public consent and citizen acceptability. Is there a regional bias of public views of renewable energy technologies depending on relative presence of these

technologies in particular regions? Possibly a high level view on what has changed, if anything?.
Industrial decarbonisation Possibility for a high level 'helicopter view' on industrial decarbonisation? Comparing different parts of the UK, what are the commonalities and differences re. industrial decarbonisation? Are the challenges different in each location? How is this learning shared? (inter region and/or inter industry) What is the evidence base on roadmaps/ strategies in different regions or countries (e.g. Scotland)? This could also include consideration of the issue of just transitions. May be suitable for an evidence review or perhaps something under the UKERC Flexible Funding?

Box 6: Other topics/areas of interest raised by Cardiff attendees

Key Wales-specific challenges In respect of the Welsh 95% emissions reduction target – large % of emissions come from industry. Challenges around farming, housing stock (relatively high share is off grid), transport. Of these challenges, industrial decarbonisation crucial (see above and below). Climate justice and equity of what happens to employees in affected industries (just transitions) is really important (see above), and linked to how to make sure that the low carbon transition benefits the economy as widely as possible.
Industrial decarbonisation Industrial decarbonisation – what is the scale of the challenge? 16% of total emissions from steel, 42% of total emissions from industry and energy. There is potential overlap between this area and FLEXIS work. What is the international experience in respect of industrial emissions abatement? (BEIS may have evidence on this). What does resource efficiency look like from a business perspective? How are business models changing? Net zero work from National Grid. Energy kingdom work – Milford Haven zero carbon zone – is it possible? How can we create a flexible future energy system that is co-dependent between electricity and gas including incorporation of waste streams? Major landscape change, including changes in land use linked to industrial decarbonisation (e.g. industry paying farmers to change their use of land to offset industrial emissions that cannot be abated). Not clear whether these issues/areas are amenable to a UKERC TPA project?
Energy efficiency 'sweet spot'

What is the sweet spot between energy efficiency interventions now and waiting for decarbonisation of primary energy sources (balancing cost/affordability, carbon reductions at source vs at point of consumption)? What should the relative balance of priorities be? Very deep retrofit is a big issue with low-value housing stock. Many problems with insulation work are related to poor quality of installations. Further issues facing off-grid houses. Not clear whether these issues/areas are amenable to a UKERC TPA project.
Commercial buildings Lots of work done on domestic energy efficiency retrofit (see above) but not so much on commercial (large retail buildings and offices). What are the challenges around commercial building stock and is there any evidence base here for what works?
Locating renewables What are life cycle implications of future technologies? Need to be considered early on in project development to optimise their location e.g. water requirements. Is there a use/role for LIDAR to identify the most optimal locations to place renewable energy installations? More likely that this could be a candidate/opportunity for UKERC flexible funding?
Useful resources to understand the Welsh context Resources - Smart Living report (June 2019) has lots of useful contextual information (may help to understand how TPA work might fit in with activities that are already going on). Fit into what is happening through EICH, ISCF (road map). Local Delivery Plan published March 2019. Look at ‘smart networks’ portal for details on what’s going on in respect of networks.

Table 4: Cardiff attendees and affiliations

Rob Bailey (Welsh Government)
Ceri Davies (Natural Resources Wales)
Charlotte Gibson (Welsh Government)
Luci Gleeson (Wales Chief Scientist Office)
Rob Gross (Imperial College and UKERC TPA)
Richard Hanna (Imperial College and UKERC TPA)
Karen Henwood (Cardiff University and FLEXIS)

Phil Heptonstall (Imperial College and UKERC TPA)
Marcia Jones (Welsh Government)
Ron Loveland (Welsh Government)
Lucy Mason (Wales and West Utilities)
Nick Pidgeon (UKERC and Cardiff University)
Jennifer Pride (Welsh Government)

Belfast – January 2020

Attendees were split into six groups and each group was asked to generate, and if possible prioritise, a list of potential topics for future UKERC TPA projects. Within each group there were wide-ranging discussions covering many topics and areas of interest. The notes from each group are shown below in Boxes 7 to 12. These notes vary in format between groups, reflecting the differing approaches and discussions taken by each group, and the degree of consensus within groups. Attendees are listed in Table 5.

Box 7: Notes from Belfast Group 1

Top two priority topics identified:

Demonstrators

What are appropriate business models to support demonstration projects in Northern Ireland and other UK regions? The role of demonstrators in de-risking technologies: comparisons of different business models, policy support and regulatory frameworks. What would be the optimum demonstrators for Northern Ireland?

Achieving Net Zero

What is the most effective way to incentivize a net zero whole energy system (and fit with Northern Ireland energy strategy)? This topic would take a holistic, whole systems perspective and consider the circular economy, net zero and decentralisation.

Other Northern Ireland specific topics discussed:

- Social – behaviour change requirements;
- Heat – reduction / removal of oil and reduction of fuel poverty; district heating networks;
- Heat recovery – from a range of sources;
- Decarbonising transport;
- 5G and energy demand;
- Energy storage – wider grid support applications but not specific technologies;
- Stranded assets which might result from abandoning the gas grid;
- Markets and regulatory frameworks. Expanding markets – deployment of storage at a domestic level;
- Tidal energy opportunities – e.g. ensuring build in 200MW consented site off the north coast of Northern Ireland.
- Retrofit and building regulations.
- Vehicle to grid.

Box 8: Notes from Belfast Group 2

Top two priority topics identified:

Local authorities and local area energy planning

Local authorities' role in the energy transition and where local councils fit in. Local authorities have a role in planning, but now councils are looking at a regional role, beyond looking at their own buildings.

Consumer engagement

The role of consumers and consumer engagement. Understanding how local authorities can help with, and reduce obstacles to, more effective consumer engagement.

Additional priority topic suggested:

What's the best energy system for a local area – how do different energy sources and infrastructure fit together? In Northern Ireland, there is lots of wind being curtailed, extensive use of oil, possibility to expand gas network / use hydrogen: is there enough modelling to understand which combinations would work best?

Box 9: Notes from Belfast Group 3

Top two priority topics identified:

Heat demand mapping

Development of a granular heat demand map, collating existing datasets: using Northern Ireland as a case study and trial for the methodology, with potential to roll out to the rest of the UK. Using GIS to characterise heat demand and time-of-use at a building by building level (including residential and commercial buildings). The heat map would also characterise industrial users according to temperature, timing of use and flexibility.

Retrofitting or rebuilding

Developing a building refurbishment and rebuilding decision toolkit. Given poor energy performance in existing UK housing stock, this would help to determine whether it would be better (on a case by case basis) to retrofit or to build a completely new building. The toolkit would take into account capital costs, embodied energy and carbon in buildings, and operating costs.

Additional priority topic suggested:

Governance and capability

How do we link government departments who all have responsibility for energy, e.g. departments with transport, housing or industry portfolios? What is the capability of

government to access specialist expertise, and how quickly can government decisions be made? How does government arbitrate / make cross-sectoral decisions when lobbied by differing interest groups, e.g. with respect to large infrastructure projects?

Review of international approaches and exploring how governance and capability works in other countries in the above respects.

Other potential topics discussed:

- Vector interactions and grid balancing, with respect to demand management, storage, peak reduction and fuel mix during peaks. Use of whole system energy model to simulate vectors / interactions: electricity, gas/oil, transport, heat.
- Current technology pathways and technology mix – what is the most viable pathway / mix for Northern Ireland?
- Offshore energy in Northern Ireland – a missed opportunity?
- The Northern Ireland gas question: should NI continue to expand its gas grid to reduce reliance on oil, and if so, to what extent (e.g. industry, housing)? What should be the role of alternatives to gas domestic heating such as low temperature district heating? NI review of heat demand and characterisation map: delivery temperatures; peakiness of demand; and flexibility.

Box 10: Notes from Belfast Group 4

Top two priority topics identified:

General heat strategy and oil replacement in Northern Ireland

Heat pumps and fuel poverty: how does the cost of heat pump installation affect vulnerable, fuel poor households?

Expansion and continuation of gas network: will gas be stranded, and what is the potential for hydrogen production from natural gas?

There is a high percentage of prepayment meters in Northern Ireland. What is the impact of prepayment meters on household behaviour?

Energy, food and waste: circular bioeconomy

Energy and food / energy and waste with a circular economy focus. Energy and agriculture: how to decarbonise farming. Energy and waste: potential use of waste for energy production. Energy production and fit with the circular bioeconomy: towards net zero carbon.

Additional priority topic suggested:

Social acceptance and renewables

Social acceptance of renewable technologies including bioenergy and wind. Understanding how to get people to use renewable energy more and reduce their energy consumption.

Other potential topics discussed:

- Need for wider portfolio of renewable energy sources / technologies beyond bioenergy and wind: wave, tidal, storage facilities.
- Fuel cells and storage: domestic and industrial aspects.

Box 11: Notes from Belfast Group 5

Top two priority topics identified:

Heating, health and fuel poverty

Making homes healthier by providing heat outside of normal heating times: the role of low-cost variable renewables. Increasing health in homes includes pollutant removal, addressing problems such as excess moisture / humidity, VOCs (volatile organic compounds) e.g. formaldehyde, and carbon dioxide in bedrooms.

Waste water and community heating

Feasibility of using sewage waste / waste water / open water heat pumps in community heating for new housing developments.

Box 12: Notes from Belfast Group 6

Top two priority topics identified:

Impact of policy on rural populations

Differences between user behaviour in rural and urban areas – conflict between experience (e.g. from field trials) and what should be happening.

Natural gas and net zero

Is natural gas to decarbonisation like cannabis a gateway drug? Role of gas infrastructure in net zero decarbonisation pathways – is natural gas compatible with achieving net zero? In Northern Ireland, there is not enough biogas to replace natural gas. NI-specific: cost-benefit analysis of gas network expansion in a net-zero pathway.

Additional priority topic suggested:

What is the most effective governance / regulation for retrofitting homes and buildings?

Other potential topics discussed:

- Diverse, decentralised mobility in Northern Ireland and legacy of the Troubles. Impacts on mode of transport availability and choices for school run, home / work commute and shopping. Disconnect between spatial distribution of work / school / home and how this has implications for mobility, energy / travel demand and planning.

- Education – need to educate the public and installers – not just about educating younger people.

Table 5: Belfast attendees and affiliations

Name	Organisation
Adrian Pugsley	Ulster University
Alberto Longo	Queens University Belfast
Andrew Cupples	NIE Networks
Andrew K Trimble	Renewable Heat Association Northern Ireland
Andy Frew	NIE Networks
Anne Marie Mcgoldrick	The Electric Storage Company
Brian Hood	BS Holdings Ltd
Caterina Brandoni	Ulster University
Ciaran McGrath	Derry City and Strabane District Council, NI
Daniel Parke	Antrim and Newtownabbey Council, NI
David McGowan	SONI Ltd
Dominic McLarnon	Ulster University
Fiona McCausland	Department for the Economy
Frank Given	Close Focus Limited
Gerard Mcilroy	Mutual Energy
Inna Vorushylo	Ulster University
Kajsa-Stina Longuere	UKERC Operations Manager
Karen Mooney	Queens University Belfast
Laura Fitzmaurice	Ulster University

Mary O'Kane	SGN Natural Gas
Ming Huang	Ulster University
Meabh Cormacain	Department for the Economy
Mohammad Abid	Ulster University
Osaru Agbonaye	Ulster University
Pat Austin	National Energy Action
Paul Matthews	Invest NI
Philip Griffiths	Ulster University
Phil Heptonstall	UKERC and Imperial College London
Richard Boyd	You Generate CIC
Richard Hanna	UKERC and Imperial College London
Robert Gross	UKERC Co-Director and Imperial College London
Roisin McLaughlin	Utility Regulator
Ruchira Ghosh	Ulster University
Sam McCloskey	Centre for Advanced Sustainable Energy, Queens University Belfast
Sam Knox	Invest NI
Stephanie Ogunrin	Ulster University
Steven Devlin	Ulster University
Thomas Byrne	Department for the Economy
Thomas Cromie	AgriAD

London – February 2020

Attendees were split into three groups and each group was asked to generate, and if possible prioritise a list of potential topics for future UKERC TPA projects (ideally identifying a 'top two' within each group).

Within each group there were wide-ranging discussions covering many topics and areas of interest. The notes from each group are shown below in Boxes 13 to 15 below. These notes vary in format between groups, reflecting the differing approaches and discussions taken by each group, and the degree of consensus within groups. Attendees are listed in table 6.

Box 13: Notes from London Group 1

Top two priority topics identified:

1) Hydrogen: 'Better together: what are the system and economic benefits of hydrogen and electrification working in partnership?' Potential sub-questions/areas could include:
   - H_2 vs electrification in heat and transport.
   - Role of hybrid heat pumps in managing peak demand.
   - H_2 in managing variability and inter-seasonal storage.

2) Local energy: 'Opportunities and barriers for energy planning – role of multi-level government and RIIO2 in long-term decision making'. Potential sub-questions/areas could include:
   - Respective roles of national, city and local governments.
   - RIIO2 – does/should this factor in local energy planning?
   - Community energy strategies – what are the powers of local authorities, do/can they engage with networks? How do they align time horizons?

Additional priority topics suggested:

3) System resilience: 'What are the biggest risks to smart system security, and what plans are being developed to mitigate them? Potential sub-questions/areas could include:
   - What are the risks? Internal (system management, capacity, capability) vs external (cyber security, supply chain (coronavirus!!))

4) Cost reflective pricing: 'Are we ensuring the most vulnerable consumers are protected through the transition?: Potential sub-questions/areas could include:
   - Impact of the no free riding principle; large/wealthy users going off-grid, leaves the least able to manage picking up the tab?
   - Impact of charging reforms and fixed/capacity charging.

5) Learning the lessons of historical policy errors. Potential sub-questions/areas could include:
   - Why did the UK miss out on industrial benefits of wind, batteries etc?

Why did these develop in Europe, America etc?
- What lessons can we learn from this?
- What mistakes are we repeating? What are the emerging technologies that we are about to miss again? Marine energy, cooling technologies, large scale storage?
- On the systems side – how do we ensure we are future proofing the system and users? (e.g. new build homes are being connected assuming 1.5kw load…)

6) Economics of green growth. Potential sub-questions/areas could include:
- What are the assessments of the economic benefits of low carbon growth? Jobs, GVA? How can this be measured?
- Forecasts of economic benefits?

Other topic ideas generated by this group:

- What does a fair transition look like for consumers?
- User segmentation – not all consumers are the same? How will transition impact different users?
- What is the role of the individual? How can individual action change corporate action?
- IDNO and After diversity maximum demand – what is current practice? Are we future proofing?
- Retrofit financing? What has worked?
- Open data – barriers to access and good practice?
- Smart charging and V2G – what is working. Barriers?
- Inter-seasonal storage – what technologies are emerging?
- Critical materials – what is future demand? What technologies are reducing use? (e.g. Greenspur Wind)
- Natural capital – what is it? What are the other environmental effects of the transition? What is the role of offsetting?

Box 14: Notes from London Group 2

Top two priority topics identified:

1) Co-benefits i.e. what are the co-benefits of net zero?
- Co-benefits are taken to mean the socio-macroeconomic side of the net zero transition, i.e. following more renewables and lower energy demand what are the other benefits, health, lifestyle, avoided energy infrastructure costs?
- Note that the Grantham Institute has published a briefing on this.
- This seems a 'hot topic'. The treasury net zero review is excluding co-benefits but it is something they would like to return to later in 2020/beyond, so the timelines could fit in.
- CCC and BEIS are also active in this space, and are interested in this too.
- What evidence is there on co-benefits of the net zero transition? Focus

on things like:
- Definitions and types of co-benefits.
- Deriving and applying a monetary value of co-benefits, evidence of types of savings.

2) Just transitions in energy:
- Current evidence is quite vague/woolly on this.
- CCC has a strand on just transitions.
- TPA could provide the different definitions, and then go into details/studies
- Pension funds? Is this in scope?
- Matt Hannon at Strathclyde is looking at this for 6 months as an REA.
- Distribution of costs: Leeds University did something on electricity bills vs general taxation.
- Costs of net zero: assumption this falls on consumer. How do firms pass through policy costs?
- What have been the socioeconomic impacts of previous energy transitions, and what does this mean for net zero and achieving a just transition?

Additional priority topics suggested:

3) UK net zero scenarios (energy system modelling):
- Scenarios:
  - Thousand flowers, CCC, IPCC, National Grid. The TPA could look at these/others to see what common areas there are.
  - IPCC does global scenarios, but we don't have UK-only IPCC scenarios.
  - Do scenarios focus enough on behavioural side? Is it just lots of technology?
- Data/modelling inputs
  - Measurement/tracking:
  - Do we have the right modelling/tools to track progress to net zero?
  - Access to smart meter data.
  - Question: what data is used in what models, and what are the common data sources? Met Office and using energy weather data, does this come from just one source/origin?
  - BECCS & assumptions would also fit here.
  - For example, CCC and BEIS might rely on one study/data source in 2011 for decarbonisation in housing, for example.
  - Cost data £/MWh. Is this up to date?
  - Behavioural side/actors? Half hourly data scale.
  - Are the models fit for purpose for net zero?

4) Nuclear:
- Where are we with this in relation to net zero?
- Is this too controversial for TPA?
- Is there a role for nuclear?

- Maybe this is more of a hot topic that's better in a UKERC research strand?
- Small reactors SMRs.

5) Energy Storage:
- EVs and hydrogen: net zero is setting a new agenda/focus. We will need energy storage (and lots of it).
- Short term 1-3 days, medium term 1-3 weeks, long term storage options.
- Note: Royal Society are producing a storage report due in March 2020 for short/medium/long term storage of energy. This might have a TPA overlap.
- TPA could look at net zero scenarios and the implications for storage.

6) Supply chain:
-Exploring what are the supply-chain issues of net zero pathway:
    - Industry: needs to know scenarios of heat pumps, so they can prepare.
    - Supply chain for EVs – maybe the ICE phase out 2035 sends a signal to the supply chain, so that's sufficient info for industry to respond.
- Skills shortages/impacts
    - Retrofit for example: looking at the skills required for training.
    - Also moving people from offshore/Oil & Gas to renewable/wind turbine industry. Transferable skills?
    - Royal Academy maybe has done work on this?
    - National Grid have just finished a study on skills for net zero.
    - Could be a good topic for industry to work with the TPA.

7) Local energy topic:
- Will decentralised energy lead to more energy governance?
- Is Ofgem fit for purpose in a more local energy system?
- Fragmentation of national-to-local, should Ofgem be stripped back?
- Review wider/outside the UK experience. What have they done as their systems get more renewables-based? Have they become more or less decentralised? How have their decentralised energy governance systems developed?
- iGov have looked at this a little in terms of governance (not regulation)
- Fair for the Future https://www.sustainabilityfirst.org.uk/fair-for-the-future are doing a project in terms of the regulator stepping back
- Note that the National Audit Office published a review on regulation / Ofgem in 2019.

8) Offsetting of emissions:
- By this we mean: tree planting, etc.
- Group endorsement of the topic (which was raised in the July 2019 internal UKERC consultation).
- Offsetting mechanisms. How do these work globally?
- Can everyone go net zero but only to 75% carbon reduction, and plant trees for the rest?

- Double counting issues?

Box 15: Notes from London Group 3

Top two priority topics identified:

1) What is the magnitude of the impact on the energy sector of decarbonising other sectors of the economy?

2) Review of policy/regulatory approaches to implementing interventions for energy/carbon efficiency improvements in the domestic sector and review of their effectiveness in other countries.

Additional priority topics suggested:

3) What is the market landscape for domestic demand response appliances/equipment and which of these has the greatest potential for providing coordinated demand response to the system?

4) What applications (CCS, energy storage tech, etc.) should get priority access to the limited geological storage capacity in the UK?

5) What are the risks and barriers associated with implementing low carbon technologies (e.g. hydrogen for heating) at a city scale?

6) What are the relative cost impacts of achieving net zero for different demographic groups (e.g. urban vs rural, rich vs poor)?

7) What grid-scale energy storage technologies are available and what could the combination look like for a decarbonised energy sector in the UK?

Table 6: London attendees and affiliations

Barnaby Wharton	RenewableUK
Elsa Barazza	University College London
Ioanna Ketsopoulou	UK Energy Research Centre
Jasmin Cooper	Sustainable Gas Institute
Judith Ward	Sustainability First
Hunter Danskin	Department for Business, Energy & Industrial Strategy
Madeleine Morris	EnergyREV
Mike Hemsley	Committee on Climate Change
Nick Ash	Ricardo
Paul Brockway	Leeds University

Paul Jordan	Energy Systems Catapult
Phil Heptonstall	UKERC and Imperial College London
Philip Sellwood	Energy Saving Trust
Rebecca Rosling	EDF Energy
Richard Hanna	UKERC and Imperial College London
Robert Gross	UKERC Co-Director and Imperial College London
Simon Bittlestone	National Audit Office
Xinfang Wang	Birmingham University