



Original research article

Prioritising business model innovation: What needs to change in the United Kingdom energy system to grow low carbon entrepreneurship?

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ABSTRACT

'What needs to change in the United Kingdom energy system, to allow low carbon business models to thrive?' Earlier work by the authors has reported that up to £21bn of new financial value could be available to electricity utilities by 2050, in a low-carbon UK power sector. This represents up to 30% of future electricity markets. To capture new value, electricity utility business models need to evolve. This research used an elite 'decision theatre' method, in the UK, USA, and Europe, to decide on the most important changes required to the energy system to enable new [low-carbon] utility business models to thrive. The results show that there is substantial agreement on the five requirements for change, these are: (1) Clear national heat and electric transport strategies; (2) Commitment to sufficient carbon prices; (3) Simpler, principles-based regulation across the energy value chain; (4) Accessible markets for flexibility and other energy services; and (5) Managing consumers' exposure to risk. These were the changes that participants considered most important to foster low-carbon utility business model innovation. This work suggests focusing on business model innovation as opposed to technological innovation could accelerate decarbonisation, and extends the use of the Decision Theatre method in social science energy research.

1. Introduction

The transition towards low-carbon electricity systems is not fast enough to avoid the worst impacts of climate change [1]. Rapid and widespread electrification of heat and transport, and an accelerated deployment of low [or negative] -carbon electricity generation is required [2]. In the absence of a deep revolution in the structure of liberalised energy markets, society relies on commercial decision making to: commit investment capital, create low-carbon energy offers for consumers, build low-carbon capacity, and find new ways of balancing the system with reduced availability of fossil fuelled flexible plant [3,4].

Recent work has shown there is an annual opportunity of up to £21bn by 2050 created by UK electricity transitions [5], and sector analysis shows that business model innovation will be needed to capture this new value [6,7]. This means new utility business models must emerge to translate potential new value into delivery of low-carbon systems.

Here we argue that new business models can be essential drivers of systemic innovation across the energy sector. The lack of focus on business model innovation means there are only tentative steps into real business model transformation in utilities in the United Kingdom (UK

[8]. This study aimed to understand the key change requirements that will enable utilities to capture new value and deliver low-carbon energy systems.

We use an internationally applied 'Decision Theatre' method, convening high level stakeholders in the energy system; to prioritise the changes required to allow new, low carbon business models to thrive in the UK market. To our knowledge this is the first attempt to set priorities for whole system change from a business model innovation perspective. It is also the first attempt to use a decision theatre method in whole energy systems research.

The elite participant sample, drawn from across the UK, European Union (EU) and United States (US), generated strikingly common priorities for the UK energy sector. These are analysed in the results and discussion sections, and we conclude with the implications for current energy policy.

2. A business model perspective on energy transitions

To explore the changes needed to an energy system from a business model perspective, it is important to define what a business model is, where new value comes from, and explore why business model innovation is needed to capture new value.

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All energy transition scenarios in liberalised markets, create and destroy commercial opportunities in different parts of the energy value chain [9,10]. This creation and destruction of value disrupts established utilities and the business models they operate. All low-carbon scenarios require substantial changes to the institutions, technologies, user practices, and business models of the current energy regime [11,12]. Until recently however, one of the least understood aspects of energy transitions was the business model element of the system [13].

Seen from a co-evolutionary perspective, business models are not financial propositions or profit formulas, but units of analysis to understand, evaluate and compare how businesses create, deliver and capture value. Using a co-evolutionary lens, that creation and capture of value can be seen to influence and be influenced by other system elements like policy, regulation or user practice [14,15]. While energy markets are theoretically open to any form of business model that can satisfy market rules; as in other sectors, economies of scale, increasing competencies, and efficiency returns [16,17] mean a few similar business models dominate – they become incumbent. In the energy market the corporate volume sale utility has become the incumbent model [18,19]. Recent work on energy business models addresses how pressures created in other parts of the energy system such as technological change, climate change commitments, and new consumer preferences, drive incumbent business models to evolve [18,20–22]. A co-evolutionary perspective leads us to explore the relationship between discrete elements and analyse these with a view to managing energy transitions [23].

These studies have greatly improved our understanding of the co-evolution of business models and the energy system [24]. However, no work has yet defined how energy policy can specifically support system wide business model innovation; we argue that more attention must be paid to business model innovation as a *driver* of system decarbonisation [25,26].

2.1. Business models and new value as the driver of decarbonisation

Much of the wider business model literature assumes business models ‘create, deliver, and capture’ value for customers; yet in the energy sector, value is created by transitions that are a long-run product of increasing environmental action, new user practices and technological change, all of which can arise exogenous to the ‘utility’ business model or its individual consumer base [27].

This notion of value *creation* is critical. Directing a national energy system towards a particular future, inevitably destroys old values and creates new ones. Whilst policymakers in market-led economies state they are not in the business of picking winners, there is no energy policy that does not inherently favour either incumbent or challenger interests [12]. Energy policy creates or destroys value, and the extant basket of energy policy ‘locks in’ certain types of energy transition [28,29]; simultaneously new financial opportunities are created in markets such as flexibility, servicing transport and heat electrification, and infrastructure operation [30], we call these volatile financial opportunities ‘value pools’.

Value pools are *opportunities* for revenue extraction and investment, financial possibilities which may or may not materialise. In the business literature they are derived from ‘value propositions’ [31]. The difference between a value proposition and a value pool, is typically that a value pool is measurable, a monetised opportunity. Energy policy can create or destroy these value pools, by steering energy transitions, but so can other developments beyond policy such as new technologies or consumer needs, wants and desires [32]. For example see how energy policy can create a market for flexible capacity [33] or destroy the market for coal derived electricity [34]. Previous work by the authors has demonstrated that up to £21bn per annum of new value is available in the UK by 2050, and depending on scenario this represents up to 30% of the future market.¹ To capture a new value pool, business model innovation is needed [35,36].

Wainstein and Bumpus [25] argue that innovation policy has focussed too much on bringing new technology to market, and that irrespective of new technology, business model innovation itself can accelerate energy transitions. Roelich et al. [37] and Bolton and Hannon [38] explore how business model innovations could fundamentally alter the unsustainable throughput based business model, dominant in the energy market. Johnstone and Kivimaa explicitly separate business model and technological innovation as disruptive forces, and state: “*the interplay between technological and institutional factors [such as business model evolution] seems to be important in energy disruption but has received little specific attention and conceptual development*” [39] We accept that business model innovation has the potential to drive change, and that business model innovation is driven by new value creation on a systems level. This leads us to ask: ‘what needs to change in the energy system to allow low-carbon business models to thrive?’

Recent work by Heiskanen, Kivimaa, and Lovio [40] on institutional entrepreneurship shows that initiatives to change the institutional conditions of the energy field require somewhat different skills than business-as-usual policy development, and our system wide questioning of institutional needs for business model innovation fits this call 40

3. Methods

3.1. Decision theatres as discursive method

Decision-making around energy transitions is a complex web of intersecting interests, policy programmes, and socio-environmental impacts. A dynamic interaction of lobbying positions, market strategies, environmental pressures, social movements and technological change, mean that it is difficult to separate what needs to be done to accelerate energy transitions, from what needs to be done to protect power and vested interests [12,41–43]. Compounding this problem is the well-researched phenomena of uncertainty in energy transitions [44]. Here, the complexity of the system makes it difficult to reliably manage outcomes, often leading to unexpected consequences [45]. Those trying to steer energy transitions are often left with problems of uncertainty, but the compulsion to make decisions and enact programmes of change, given the pressing need for decarbonisation.

Diverse approaches have arisen to inform decision making under uncertainty, these include straight policy oriented research [46], cost benefit analysis [47], and multi-criteria decision analysis [48], robust decision making [49] and cost optimisation analysis [50]. Each of these fields has strengths and weaknesses, indeed each is open to bias [51,52], but chiefly there is a tendency to analyse clearly defined options or programmes which lend themselves to computation, quantification and cross-comparison. The decision theatre method differs in that it provides a framework for participatory, discursive, and qualitative decision making albeit, often informed by the more quantitative approaches cited above.

Decision theatres are being used internationally to tackle complex, multi stakeholder issues with cutting edge analytics and discursive deliberation. Arizona State University pioneered the use of decision theatres to consider decision-making in a context of climate uncertainty. Their study explored the complex relationships that exist between rapidly growing populations and finite water supplies [53]. Decision theatre techniques have been used to explore complex issues of resource and infrastructure governance such as local energy infrastructures [54], urban flooding [55], and forestry management [56].

In the decision theatre method there is a focus on both the final decision made, and the dialogue of stakeholders while exploring options. This can uncover biases or illuminate motivations of stakeholders

¹ Including fixed infrastructure costs, as such ‘new value’ as a proportion of variable market size is likely much higher.

which otherwise are not well represented in a priori decisions used for multi-criteria analysis, cost optimisation or other decision tools. This attention to narrative decision making is being used fruitfully in Energy Research and Social Science [43,57,58]. These narrative approaches can fruitfully be used to make sense of a complex world of energy transitions, it can crystallise arguments and assumptions; and use storytelling [or discourses] as way[s] of understanding, communicating, and influencing others [59]. At the same time we recognise narratives are as susceptible to bias as quantitative modelling. Here we extend this approach by analysing the narratives used and decisions arrived at to prioritise low carbon business model innovation in a controlled and time limited environment.

The three key features of the decision theatre approach that were adopted for this study were:

- 1 Participants are given new information on the problem with specific relevance to the decision to be made. In previous decision theatre studies this has included information on infrastructure options or flood impacts, this can be qualitative or quantitative data [55]. Here we used new data on energy market value pools and business model proposals (see supplementary data)
- 2 The outcome of the decision theatre had to be a priority ranking of energy sector changes made on the day.
- 3 The process and dialogue of stakeholders in reaching the decision would be used to highlight areas of agreement, tension, and exploration of uncertainty.

3.2. Decision theatre sampling

The decision theatres needed to run on a sample of energy industry stakeholders with substantive roles in identifying, pursuing, or enabling business model innovation in the energy sector, Table 1 shows the sample across the four events. The research team designed a series of four decision theatres. The first decision theatre was run in May 2017 in London, with participants from UK 'present utilities', i.e. established energy companies and some new entrant challenger utilities based in the UK. The second decision theatre engaged participants from the UK Policy and Regulation community and also ran in London, in October 2017. The third decision theatre sampled internationally active utilities and investors with an interest in the UK but mainly based in Europe. This "International Perspectives (Europe)" decision theatre was undertaken in November 2017 in Berlin. The fourth and final decision theatre also sampled international participants in the UK market, but this time based predominantly in North America; "International Perspectives (US)" took place in January 2018 in Chicago. The European and US decision theatres were supported by the United Kingdom Foreign and Commonwealth Office, Science and Innovation Network who were primarily responsible for recruiting participants, for the United Kingdom events the Energy Research Partnership recruited

participants.

Our sampling strategy required respondents that were involved in high level decision making that affected utility business models in the UK market. As such we used a non-probability sample [60] of elites from the policy, regulatory and commercial sectors in the UK; and in international perspective workshops, elites from energy and power companies, investors, or sector professionals with financial or non-financial interests in the UK energy system. In this way our sample was an elite, purposive sample [61] in both UK and European/US contexts as we were concerned with identifying a small pool of influential individuals in a position to comment on both the trajectory of the UK energy market and the opportunities for business model innovation within it. Since this sampling strategy cannot eliminate selection bias we can only claim that the common themes we draw out for energy policy are the priorities of a substantial but not representative set of elite decision makers in the UK energy market.

3.3. Input data and process used in this study

Three things need to be understood to answer the question 'what needs to change in the energy systems to allow low-carbon business models to thrive?': 1) what new values are created by energy transitions, 2) what types of business model are compatible with capturing these values, and 3) what are the priority changes that can support new business models across the market.

We adopted a four-stage methodology. First, to answer the first sub question about how much value is available, we defined the size of the different value pools created in the UK by a defined set of low-carbon system scenarios. We identified six discrete value pools: plant efficiency, [household] energy services, local low carbon generation, large scale low carbon generation, flexibility, and carbon capture and storage. The calculation of the size of these value pools and detailed results are available in Wegner et al. (2017) [5].

To answer the second sub question about which business models could capture this value, we held a one-day workshop on June 15th 2016 with 38 industry, academic and government stakeholders to identify 11 future utility business models. The aim of the workshop was to co-produce and explore utility business models that could capture the values created by low carbon energy systems: From 11 business models created, the research team selected five innovative utility business models that could operate in a recognisably liberalised market [62].

Third, we stress-tested these business models for consumer desirability and technological Feasibility. The results of this stress test were included in the information to participants, and demonstrate that there are few technological barriers to the proposed business models and there is also some consumer desire for each [64,63].

Finally in order to answer the third sub question about what the priority changes needed to the energy system to support these business models, these three datasets were summarised in a preparatory

Table 1

The sample for each decision theatre.

#1 Utility 2050 Present Utilities decision theatre <i>n</i> = 10	#2 Utility 2050 Policy and regulation decision theatre <i>n</i> = 9	#3 Utility 2050 International Perspectives [Europe] <i>n</i> = 9	#4 Utility 2050 International Perspectives [US] <i>n</i> = 12
3 Large utilities executives (i.e. three of the UK's big six),	2 Civil Servant regulators,	2 Executives of established EU utilities,	2 Executives of established utilities
2 Challenger utilities officers or affiliates	6 Civil servant policy makers from energy, infrastructure and industrial departments,	2 International technology company representatives,	2 Public officers representing a state Commerce Commission
2 Executives of energy service providers	1 System operator representative	2 Energy flexibility SME's,	1 International oil and gas company
1 Generation heavy utility (i.e. making majority revenues from merchant plant),		1 EU investment Bank, investor and	2 Energy distribution network companies
1 Distribution Network Operator Executive, and		1 Energy focussed civil servant of the British Embassy.	1 Power generation developer
1 Executive of a large energy and petrochemical firm.			1 Investment Bank Officer
			1 Energy stakeholder platform company.
			1 British energy innovation company
			1 Representative of the British Consulate General.

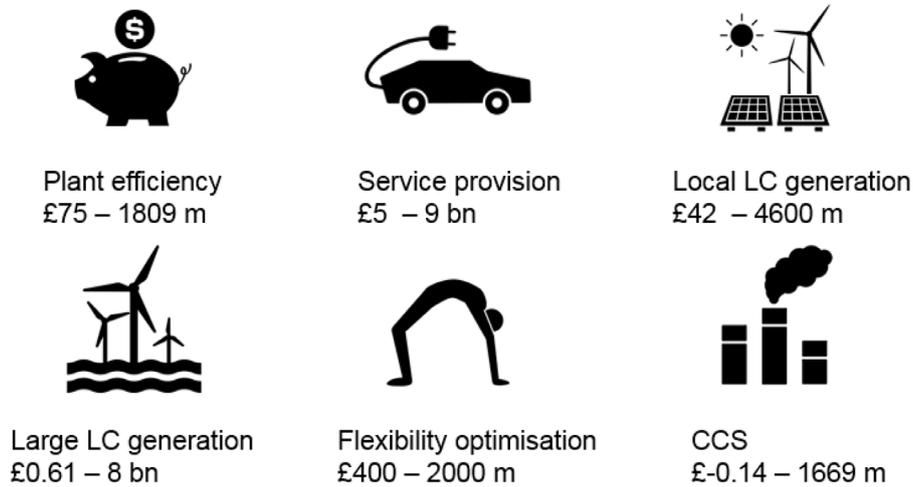


Fig. 1. Value pool sizes in 2050 under a range of UK low carbon energy scenarios.

information file for decision theatre participants and the decision theatres were undertaken between March 2017 and January 2018. In each decision theatre, participants were presented with the value pool analysis, innovative business model archetypes, and preliminary consumer data. The value pools identified are summarised in Fig. 1 with supporting primary research published in Wegner et al. 2017 [5].

The 5 business models (Fig. 2) analysed that could capture these value pools were: ‘**Pure Low Carbon Generator**’ focussed on building low carbon capacity and/or CCS, a ‘**New Electrifier**’ which installed electric heating and electric vehicle charge provision, ‘**Energy Service Company**’ offering appliances, efficiency retrofit and electric vehicle services, ‘**Peer to Peer Trader**’ for local generation and local trading of power outside existing wholesale markets, and ‘**Third Party Control**’ which essentially bundles utilities around consumer needs and takes switching decisions on the consumers behalf.

Each of the business models can capture one or more of the value pools proposed in Fig. 1. The intricacies of each business model were not presented at length but decision theatre participants were asked to use them as ways of understanding how utilities might capture new

value pools.

The decision theatre participants were then presented with the consumer insight data that suggested each business model had a nominal consumer segment to find and grow within. For a full appreciation of the preliminary data presented to participants see the supplementary materials accompanying this article [64].

Having been presented with the preliminary material both before the event and at the outset of the event, the participants were then introduced to **stage 1** which used a series of ‘provocations’ to elicit initial dialogue around business model innovation, these provocations are not reported as they were a device to begin the discursive process. In **stage 2** participants were asked to take account of the data presented and the provocations made and adopt the role of a powerful ‘system architect’ to ‘play god’ and prepare three specific changes needed in one to three sentences.

Stage 3 asked participants to work together with the combined list of change proposals produced in stage 2. Participants were asked to order the change proposal by priority, still remaining within the mindset of what would be ideal from their perspective if they were ‘in

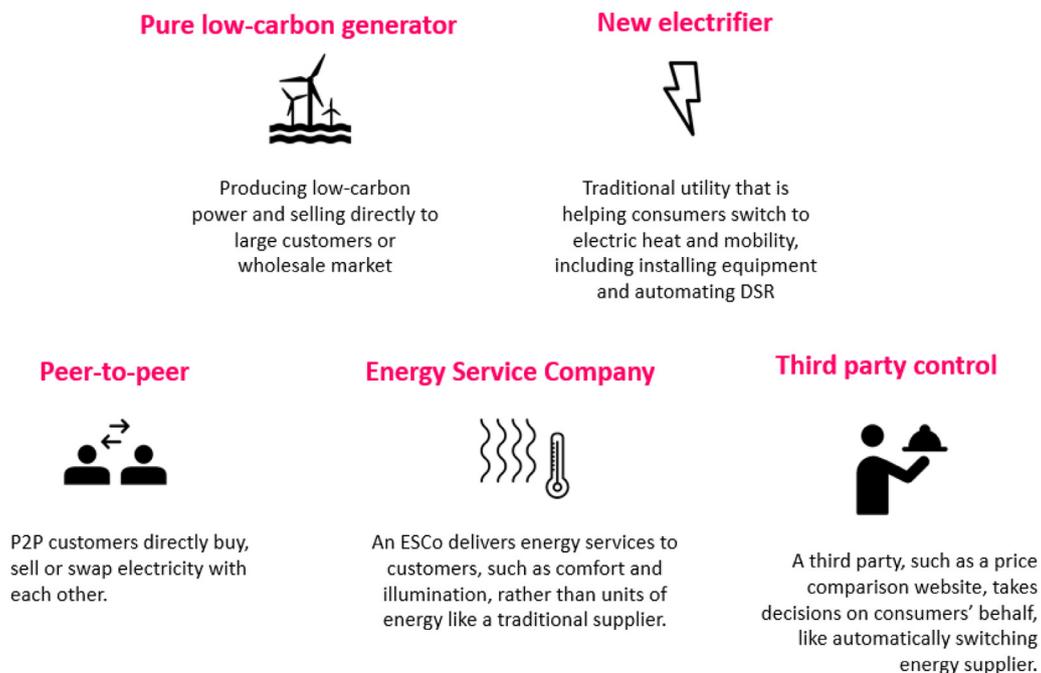


Fig. 2. The business models used in the decision theatre.

charge' of the system and wanted to access the value pools identified.

Stage 4 took the prioritised list of 'system architect' changes and asked the decision theatre stakeholders to consider the other communities involved in delivering the UK energy transition. This included consumers, regulators, politicians, utilities and civil society. This exercise aimed to take a list of actions entirely aimed at allowing utilities to access new financial value pools and reflect them against the known constraints of markets, consumers, energy politics, and the goals of system regulation.

Stage 5 took the re-prioritised list and finalised the decision process by taking the highest priority change proposals and re-writing these as concrete actions that could be undertaken by different system stakeholders.

Finally, after the last event, the research team explored the empirical reports from each decision theatre and analysed the change priorities and discursive process for common themes.

4. Results

In stage 2 we asked each group to 'play god' or 'become the system architect', using preliminary information on business models, value pools, and consumers, to create change proposals with no limits on their own power. 71 change proposals were generated across the four workshops, all intending to facilitate business model innovation as opposed to technology led innovation. The common proposals were grouped by theme as shown in [table 2](#):

[Table 2](#) shows in that UK Present Utilities decision theatre participants had the clearest and most disruptive proposals for regulatory change. This contrasts with the timidity of the UK Policy and Regulation decision theatre in the regulatory space and shows there is more appreciation of the need for strong regulation from utilities than anticipated. In the US and European perspectives regulation proposals were largely deregulatory. There was a disconnect between what the utilities that operate in the UK market, and those that regulate that market, are comfortable discussing. Each decision theatre (apart from the US perspective) proposed stronger policy frameworks as key to business model innovation.

There was substantial concern over what degree consumers are exposed to price risk. This arose from a recognition that many innovative business models deliver value from avoiding peak pricing. The question in both UK context and in Europe were to what degree this is acceptable. In all decision theatres a stronger role for the state in various parts of the value chain was expected to unlock innovation in others. On economic instruments there was a wide diversity of opinion from a re-instigation of direct subsidy for individual technologies to a completely free market.

Stage 2 showed the value of the decision theatre approach opening up the dialogue to discuss what was needed or what might work as opposed to what could be quantified and assessed within the current market framework. In this way the decision theatre approach is not limited by what can be modelled. The next step was to take these 71 proposals and prioritise them.

In stages 3 and 4 we asked participants to prioritise change proposals, firstly as they were, and then secondly with reference to other stakeholders in the system. In supplementary materials 2–5 the full process for each decision theatre is detailed. Here, we draw out themes of the prioritisation exercise across the four decision theatres, and present the final chosen priorities.

4.1. UK Current Utilities

In the UK present utilities case, the persistent value of electric vehicle charging drove much of the discussion of how system changes could unlock business model innovation around this value pool. There were also a substantial number of change proposals de-prioritised, as they were felt to be unrealistic or too disruptive, in particular those

around state control, ownership, and risk taking. At the same time proposals for a stronger policy framework were maintained, particularly around heat decarbonisation. We did not find an appreciable difference between the proposals of new entrants Vs incumbent firms. A substantial amount of discussion centred around the impact of new business models on consumer, particularly in exposing households to both upsides and downsides of flexible/cost reflective pricing. Business models that protect consumers from peak pricing depend on exposure to peak pricing in the first place, managing the extremes of this risk were a priority concern.

The most important changes the UK Present Utilities sample created were:

"We need an electric vehicle strategy that recognises whole system cost and opportunity"

"We need a simpler institutional framework to support the energy transition"

"The regulatory framework needs to adapt so that new products and services can emerge"

"New markets need to develop to allow customers to benefit from flexibility, while maintaining an acceptable social contract"

"There must be long term certainty about UK carbon pricing that is compatible with the Paris agreement"

"We need a national strategy for the electrification of heat"

4.2. UK Policy and Regulation

In the UK Policy and Regulation decision theatre, there was an overwhelming focus on consumer protection and the measures through which consumer protection could be achieved while at the same time allowing low-carbon business models to thrive. The following direct quote from one participant is illustrative:

"... no matter what is being done or trialled, the consumer protections need to be first. It is not negotiable."

Source: UK Policy and Regulation Decision Theatre participant, 2017

This drove much of the discussion and centred around whether consumer protection could be best achieved by trying to regulate individual business models, relying on a set of regulatory principles, or abandoning energy regulation and relying on enhanced consumer protection law. While relying on general consumer protection law was a popular idea to drive innovation, stakeholders felt it would be hugely difficult operationalise because:

"There is a difference between consumer protection law covering products, and regulating a system to manage risks of legal but regressive trends".

Source: UK Policy and Regulation Decision Theatre participant, 2017

In the end a fall-back insurance method was proposed for consumer protection. With consumer protection agreed as a first order concern, the decisions on other change proposals were shorter but centred on the principles of sector regulation, moving away from prescriptive regulation to 'principles-based regulation' across the supply chain, from generation through to retail and consumption/prosumption. Equally, the market for flexibility services was seen to be diversifying, with little clarity on how new entrants can identify opportunities if multiple platforms exist for flexibility services, specifically at system operator and distribution level.

The most important changes the UK Policy and Regulation created were:

Table 2
Themes emerging from 71 change proposals from four decision theatres.

Theme	Decision theatre UK Current Utilities	UK Policy and Regulation	European International Perspectives	US International Perspectives
State control, ownership or risk taking.	<p>“Decide upon free market or central planning: The current model is a mix of central planning of free markets the change recommendation was to have one of either: removal of all central intervention or full central planning.”</p>	<p>“Public ownership of the networks: Remove profit motive and self-preservation by nationalising the networks [...] eliminating profit maximisation and self-preservation decision making.”</p> <p>“Introduce disruptive government utilities: To build trust and competition in new types of business models and with a focus on different value pools.”</p> <p>“Create future utilities policy framework: Create a clear, coherent, whole system (electricity, gas, heat, transport, industry) energy policy framework that does not pick winners – technology agnostic – to provide level playing field.”</p>	<p>“Government decision to invest in core energy infrastructure to facilitate decentralised energy generation, EVs, and Heat”</p>	<p>“Government backstops’ incentives on project funding [e.g. gov de-risks project funding]”</p>
Policy Commitment	<p>“A national strategy for the electrification of heat: A proposal to clearly plan how much heat should be electrified, where, and by when.”</p>		<p>“Push decarbonisation of heat and transport by ambitious goals and incentives e.g. housing insulation rules and support.”</p> <p>“Deliver “Gone Green” scenario, policy and regulatory clarity and stability for greater investment confidence (covering other sectors such as transport).”</p>	
Economic Instrument	<p>“Put subsidy on general taxation not bills”</p> <p>“Eliminate the capacity market: Specifically stop subsidising coal and diesel generation through the capacity market and/or take eliminate entirely.”</p>		<p>“Re-introduce subsidies for onshore wind”</p> <p>“Remove all subsidies related to energy to enable best business model to win.”</p>	<p>“...a universal, undisputed carbon tax synced to global GHG emissions”</p>
Consumer Protection or risk	<p>Expose consumers to true cost of energy: Customers must be exposed to the true cost of energy for business model innovations around flexibility to be meaningful. This includes cost reflective pricing across peaks and troughs in wholesale prices.</p>	<p>“Insulate the consumer from innovation risk: ...insurance mechanism or indemnity guarantee to allow consumers to experiment (ATOL for energy)”</p> <p>“Regulatory system to maximise cross system value: Change the regulatory system to regulate producers, networks, consumer markets, rather than by sector [...] to enable cross plays at all levels.”</p>	<p>“Allow customers to be exposed to price risk.”</p>	
Regulatory Change	<p>“Reverse unbundling: Allow network companies to extend operations into other areas of the market, particularly for storage services [...]”</p> <p>“Ensure regulatory innovation for new products and services (long term): A call for system regulation to be flexible in the retail market in order to provide innovative business models to customers that provide them with value, not on £/kWh basis but on a £/service basis.”</p> <p>“Ban fossil fuels in heat and transport: A national regulation to ban new gas boilers to move to heat pumps in new builds, ban fossil fuel combustion in road transport, and mandate <50 g/kWh grid intensity of electricity.”</p>	<p>“Rely [more] on consumer protection law: Remove all bespoke regulation/licensing and rely on consumer protection regulations. This will unlock innovation by removing regulatory barriers. The role of the supplier license to become redundant [...]”</p>	<p>“Remove supply license barriers to allow more entrants with new business models into the market.”</p> <p>“Allow renewables to enter the capacity market to allow for all forms of generation to compete on a level playing field. If not the capacity market then another, form of subsidy.”</p>	<p>“Allow wires company owners to own the means to regulate voltage & frequency.”</p> <p>“Deregulation to allow market participants by new entrants / disruptors”</p>

“Customers should be protected from innovation by a fall-back mechanism.”

“Ofgem moves to principles based regulation across the supply chain”

“Create markets, including for flexibility, that are accessible, cost reflective, transparent and technology/business model agnostic”

“Develop long term infrastructure policy framework, recognising interdependencies between sectors”

4.3. - European International Perspectives

In the first International Perspectives (Europe) decision theatre there was a clear tension between the economic logics being deployed by various stakeholders. There was no clear split in the room over the desirability or otherwise of different subsidy approaches, but there was a protracted discussion about what a subsidy free system could look like and what that would mean for investment and planning. The split between the various economic rationales involved in justifying subsidy support or capacity contracts was not explicit. The spectrum of opinion is shown by the various free market proposals “*Remove all subsidies related to energy... Let the competitive market decide on the best outcome*”, “*Allow customers to be exposed to price risk*”, mixed approaches to managing markets “*support of/access to contracts/incentives for low cost renewable generation deployment*”, “*Allow renewables to enter the capacity market*” and more clearly interventionist or state control suggestions: “*Re-introduce subsidies for onshore wind to a certain extent*.” “*Deliver [National Grid’s] Gone Green scenario, policy and regulatory clarity and stability for greater investment confidence.*” And “*Government decision to invest in core energy infrastructure*”. This discussion, on the role of the state in setting market signals for investment was clearly the strongest theme from this decision international perspectives [Europe] decision theatre.

The most important changes the International Perspective Europe sample felt would allow low carbon business models to thrive were*:

“commit to a national energy vision for 2050 including transport and heat”

“create a democratically elected decision board that has full control on energy regulation which can be held responsible”

“mandate the energy regulator to facilitate innovation and decarbonisation in line with 2050 vision”

“decide and communicate, are we going for low carbon capacity markets or energy only markets with a sufficient carbon price”

government to commit to funding foundational infrastructure to enable decarbonisation of transport ”

*One further change priority was discussed, to “**enable flexibility services on an open platform**” At this stage in the decision theatre time had almost run out. This is included here because it was an amalgam of several prior proposals, had some agreement in the room but was unable to be fully discussed in the time remaining. It is worth noting however that this was a high priority for the two preceding UK decision theatres.

4.4. US International Perspectives

In the final decision theatre, international perspectives (US), there was a marked departure from policy programmes, and state involvement as a key way to drive business model innovation. There was a tendency to place the predominant agency on the consumer, and

discussions focussed on the role of individual responsibility and the creation of more efficiently functioning markets. There was a rich discussion on the role of consumers in the future energy system. “*Consumer oriented market design*” and “*incentives and penalties on carbon / energy use*” were both initially placed as top priorities. The former was moved down to 4th priority by the end of the exercise. There was clear tension between the need to place incentives on consumers (for example a carbon tax) and trust that consumers will act in the right way. An example cited was Cape Town – “*They have 60-days left until they have no water*” – in relation to the fact that consumers haven’t adjusted behaviour despite impending water shortages. This was supported by discussions around:

“letting the market try until 2040, then we’ll just have to mandate the solution if it isn’t working”.

Source: US International Perspectives Decision Theatre participant, 2017

By the end of discussions, there was consent that if consumers are expected to play a role in the transformation of the energy sector, then it will be important that consumers are engaged and that the services available should reflect their needs and desires.

There was substantial discussion on reducing regulatory barriers. Proposals included “*reducing regulatory burden on new generation assets*”, “*deregulation to allow participation by new entrants*”,

“*simplified planning approval*” and “*simplified labour agreements*”.

These relate to both creating

space for new entrants (removing prescription in regulation) and to reducing regulatory burden on incumbents. Alongside this discussion, there was a wider theme running through the discourse on creating market structures and expanding the remit of utilities (such as distributors) so that new value available could be efficiently captured. Proposals included “*ensuring base-load generation is properly valued in terms of reliability, resiliency and safety*” and “*allowing utilities to earn a rate on technologies which increase capacity, flexibility or reliability*”.

The most important changes the International Perspective U.S. sample felt would allow low carbon business models to thrive were:

“We need to place incentives & penalties on energy & carbon use, down to the individual level to spur investment in clean energy technology and to meet carbon targets”

“We need to create open, data driven platforms to provide actionable evidence to improve & develop energy system (management) tools and regulations”

“We need to reduce regulatory barriers to drive market innovation and efficiency”

“We need to design and operate an equitable consumer-oriented market to ensure consumer Engagement and fair access to energy”

“We need to create incentives to animate the markets to ensure flexibility, resilience and reliable capacity.”

5. Discussion, defining common priorities

Five common themes emerged across the decision theatres (Fig. 3); (1) Clear carbon pricing; (2) The creation of new markets to enable flexibility and the trading of new energy services; (3) focussing on consumer benefits and protection; (4) Commitment to national heat and transport strategies; and (5) Simplified regulatory frameworks. Each of the themes identified in Fig. 3 were prioritised by two or more of the decision theatres.

Even where a final change proposal was not prioritised in every decision theatre, supplementary materials show each of these themes were present, discussed and debated. This is the first time a set of

	Carbon pricing	Markets and innovation	Consumer benefits and protection	Transport and heat strategy	Simpler regulatory framework
UK Utilities	“There must be long term certainty about UK carbon pricing that is compatible with the Paris agreement”	“The regulatory framework needs to adapt so that new products and services can emerge”	“New markets need to [...] allow customers to benefit from flexibility, [...] maintaining an acceptable social contract”	“We need a national strategy for the electrification of heat”	“We need a simpler institutional framework to support the energy transition”
UK Policy & Regulation		“Create markets, including for flexibility, that are accessible, cost reflective, transparent and technology/business model agnostic.”	“Customers should be protected from innovation by a fall back mechanism.”		“Ofgem moves to principles based regulation across the supply chain.”
International (EU)	“Decide and communicate: Are we going for low carbon capacity markets or energy only market with sufficient carbon price?”	“Enable flexibility services on an open platform”		“Commit to a national energy vision 2050, including transport and heat, with roadmap.”	
International (US)	“We need to place incentives & penalties on energy & carbon use, [...] to spur investment in clean energy technology and to meet carbon targets”	“We need to create open, data driven platforms to [...] develop energy system management tools and regulations”	“We need to design and operate an equitable consumer-oriented market to ensure consumer engagement and fair access to energy”		“We need to reduce regulatory barriers to drive market innovation and efficiency”

Fig. 3. Common themes across the decision theatres.

common themes have been synthesised from across the energy value chain specifically aimed at facilitating business model innovation. Each theme ties closely to live issues in the UK market.

For **carbon pricing** the impact of the negotiations for the UK to leave the European Union further compounds uncertainty over carbon pricing. Whether the UK will remain within the EU ETS, and whether the existing carbon price floor can still apply outside the EU ETS was not clear at the time of research or at the time of writing [65]. The message from the decision theatres, however, could not be clearer that the level and operation of a carbon tax/cap and trade mechanism is critical for the expansion of innovative business models and underpinned much innovation in the energy market [64].

Second, the **creation of new markets for flexibility** were considered critical for the development of the business models explored in this study. There are three markets in different stages of development which apply to the business models tested here. First, the system operators balancing mechanism and ancillary services markets are diversifying to allow for a greater participation of distributed assets [66]. It is these distributed assets that business models like ‘third party control’, ‘energy service company, and ‘new electrifier’ are likely to have some control over i.e. electric vehicle charging, flexible heating,

and smart devices. Second, the development of new flexibility options at the distribution level demonstrates secondary markets are available for aggregated and controllable load in specific geographies [67]. Finally, there are several attempts to create trading opportunities for distributed energy assets outside of the wider wholesale market that mirror the aims of the peer to peer business model [68], while each decision theatre prioritised an acceleration in developing these new platforms, there was also a note of caution in both UK decision theatres about creeping complexity and unintended consequences arising from having aggregated flexibility assets contracted to multiple commercial platforms.

Third, **consumer benefits and protection**. Across each decision theatre there was a recognition that exposing consumers to new business models also exposes them to new risks. The risk of suppliers failing and exiting the market is a familiar, and some mitigation measures currently exist [69], however, where retail contracts bundle services, tie energy bills to financing retrofit or smart devices, or otherwise enrol new products or services into an electricity/gas retail bill, there is a substantial risk of stranded assets and consumers being exposed or even locked-in to unexpected charges. The current regulatory system deals with only the electricity and gas aspects of this and is not yet able to

deal with more complex offers [70]. There was also a clear understanding that many of the business models proposed derived some value from managing customer's exposure to time of use (also referred to as cost-reflective) pricing. Here consumers that do not switch or do not understand the terms of the offer may be exposed to 'unacceptable' price spikes. Given the low engagement and understanding most consumers have of the energy market this was considered a *likely* systemic outcome of introducing more cost-reflective pricing. Interestingly the UK utilities framed these problems as a need to maintain a 'social contract', a concept relating to the legitimacy of higher authority and the consent of citizens [or in this case consumers] to the way the energy system [in this case] is governed and regulated through a legislative state [71]. This shows the entrance of new energy business models is not simply an effort to accelerate energy transitions but can profoundly affect trust in the whole system and its overall social legitimacy [72,73]. Without continued legitimacy new business models may stall.

Fourth, **committing to a transport and heat strategy** for the nation was seen as critical, though the UK Policy and Regulatory decision theatre did not explicitly name heat in finalised change priorities, they did consent to "*Develop long term infrastructure policy framework, recognising interdependencies between sectors*" which was derived from a discussion over the need to set clear infrastructural priorities for the electrification of both transport and heat. Both utility facing decision theatres agreed there was some clarity now on the electrification of transport but saw no such signals from UK government or from the market that a preferred low-carbon heat strategy was emerging. The utility sector is therefore delaying investment decisions and business model change on heat decarbonisation. Policy direction for heat decarbonisation was strongly and explicitly requested by both utility cohorts in the UK and EU.

Finally, across all decision theatres the **complexity of the regulatory framework** was highlighted. While there are moves from the UK regulator to simplify retail market rules towards a principles-based framework [74], there was a clear desire to see a similar move across the energy value chain. However, this approach was perceived to have uncertain system wide outcomes. Though recent work has shown real danger of regulatory capture by incumbents [41], it was unclear how a move to principles as opposed to prescriptive regulation could cope with the diversifying risks faced by the consumer, along with the diversification of market platforms for flexibility and other services. Nevertheless, there has been some exploration of how new business models can experiment in a space outside the current regulatory framework in Ofgem's regulatory sandbox trials [68], a move which decision theatre participants across the board prioritise for expansion.

6. Conclusions

This study employed four domestic and international decision theatres with existing utilities, technology firms, investors, regulators and policy makers from the United Kingdom, European Union, and United States. The aim of the decision theatres was to prioritise the most important changes needed to the UK energy system to allow low-carbon business models to thrive. The outcomes imply a diversification of the energy market away from traditional volume sale utility models to myriad retail offers, flexibility arrangements, and new trading platforms. The results were not unanimous but they were strongly clustered around the five key areas of: carbon pricing, market building, consumer benefits and protection, policy commitment on heat and transport, and regulatory simplification. The specific recommendations that can be derived from this are:

- A much stronger focus is needed on strategies for individual sectors i.e. clear heat and electric transport strategies.
- A commitment to carbon prices that are consistent with UK Climate Change act 2008 and Paris Agreement targets are key to business model innovation.

- Simpler, principle-based regulatory frameworks are required across the energy value chain.
- Accessible markets for flexibility and other services must be constructed.
- Consumers' exposure to upsides and downsides of new business models must be better understood and managed.

This is the first time an international sample of elite stakeholders has been assembled to prioritise the changes needed to accelerate business model innovation in the UK energy sector. Taking this system-wide approach distils strong policy preferences which, given the process involved in their production, are likely to meet with less resistance from the energy sector than might be expected. Importantly, these policy recommendations relate only to the changes needed to foster business model innovation. They are based on earlier arguments by the authors that business model innovation is needed to accelerate low carbon transitions as utilities explore and exploit new forms of value created by energy transitions. However, this research shows that new value in energy transitions risks never being captured if system regulation, policy and consumer protection are not paid close attention to as co-evolutionary agents.

Finally, the decision theatre method was shown to be a useful and illuminating process. It allows for the negotiation of priorities from a range of system stakeholders using qualitative judgements and narratives. It is possible that decision theatre methods could be useful tools in institutional decisions around large socio-technical systems where narrative and discursive decision making can usefully stand alongside the outputs from quantitative models. Indeed using this method the research team were able to track where and how the possibilities for re-nationalising parts of the energy market were proposed and discussed but ultimately dropped away. The early proposals on government utilities, state ownership, state investment backstops and central planning fell away as a strongly market based narrative emerged. The implications of these types of political economic decisions or options are difficult to formally model.

One weakness of this study is the framing of the article to distil and synthesise the change priorities and policy implications. Further work will build on our claim made in our methods statement, that decision theatres can 'uncover biases or illuminate motivations of particular stakeholders which otherwise are not well represented in a priori decisions used for multi-criteria analysis, cost optimisation or other decision tools'. Interrogating *why and how* such strong set of de-regulatory and market based prescriptions emerged, where and how alternative proposals were negotiated away, and where participants struggled over contradictory ideologies, will inform a further piece of analysis.

Declaration of Competing Interest

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

Acknowledgement

This work was supported by the Engineering and Physical Sciences Research Council under grant Ref: EP/N029488/1 and the Economic and Social Research Council under grant Ref: ES/M500562/1. Financial support was also received by the Energy Research Partnership, the Energy Systems Catapult, and the United Kingdom Foreign and Commonwealth office Science and Innovation Network. No funders influenced study design or analysis.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.erss.2019.101317](https://doi.org/10.1016/j.erss.2019.101317).

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