



centre for  
sustainable  
energy

# smart and fair?

Exploring social justice in the  
future energy system

Phase One report  
and recommendations

**September 2020**

Lead author and  
contributing authors:

Simon Roberts OBE  
Dr Toby Bridgeman  
Daisy Broman  
Nicky Hodges  
Catherine Sage

## Acknowledgements

We are very grateful for the funding which SSEN and WPD generously contributed to Phase One of our Smart and Fair? programme and for the challenge and support provided by Steve Atkins (SSEN) and Jon Berry (WPD) and other colleagues in both companies as we developed the work. We would also like to thank the more than 60 expert stakeholders who involved themselves so willingly and thoroughly across two workshops in testing out our ideas and helping us to try to answer questions that hadn't been asked before.

With funding from:



# Contents

|  |           |
|--|-----------|
| <b>Foreword</b>  | <b>5</b>  |
| <b>Executive Summary</b>   | <b>7</b>  |
| <b>1 Introduction</b>  | <b>23</b> |
| 1.1 Background: an energy system in transition at risk of creating new ways to generate unfairness | 23        |
| 1.2 The <i>Smart and Fair?</i> Phase One objectives  | 24        |
| 1.3 Our approach   | 25        |
| 1.4 Some of the key questions being addressed by <i>Smart and Fair?</i>                            | 26        |
| <b>2 The <i>Smart and Fair?</i> Capability Lens</b>  | <b>29</b> |
| 2.1 The Capability Lens clusters   | 30        |
| 2.2 How was the Capability Lens developed?   | 33        |
| 2.3 Candidate capabilities identified  | 35        |
| 2.4 Limitations of the evidence  | 44        |
| 2.5 Prototype to beta version – stakeholder workshops  | 44        |
| 2.6 Next steps – validation, market monitoring, ‘tool’ design and release                          | 45        |
| <b>3 <i>Smart and Fair?</i> Offer Profiling Tool</b>   | <b>47</b> |
| 3.1 The principal features of the Offer Profiling Tool   | 48        |
| 3.2 What can the Offer Profiling Tool be used for?   | 49        |
| 3.3 Who is the Offer Profiling Tool for?   | 50        |
| 3.4 Outcomes of the Offer Profiling Tool   | 50        |
| <b>4 <i>Smart and Fair?</i> Consumer Classification Model</b>                                      | <b>51</b> |
| 4.1 Summary of the model   | 51        |
| 4.2 Data underpinning the model  | 53        |
| 4.3 Modelling smart energy offers in the Consumer Classification Model                             | 57        |
| 4.3.1 Use of an adoption curve to anticipate uptake of offers                                      | 57        |
| 4.3.2 Specific offers profiled in the Consumer Classification Model                                | 59        |

|          |   |            |
|----------|---|------------|
| 4.3.3    | Modelling mitigation options to enable great participation  | 61         |
| 4.3.4    | Assessing the benefits of future energy market participation  | 63         |
| 4.4      | Consumer Classification Model modelling results   | 65         |
| 4.4.1    | Adoption of smart energy market offers  | 65         |
| 4.4.2    | Example of adoption/market penetration over time  | 67         |
| 4.4.3    | Profiles of different consumer types  | 69         |
| 4.4.4    | Single offer analysis: dynamic time of use tariff   | 76         |
| 4.4.5    | Mapping the location of different energy consumer groups  | 78         |
| 4.5      | Summary of Consumer Classification Model findings   | 81         |
| 4.6      | Next steps  | 81         |
| <b>5</b> | <b>Emerging guidelines for smart and fair outcomes, our recommendations and next steps for Phase 2</b>  | <b>83</b>  |
| 5.1      | The potential of this framework to reveal smart energy ‘winners’ and ‘losers’, highlight new sources of vulnerability, and characterise communities | 84         |
| 5.2      | Smart and Fair by when? Securing innovation and fairness over time (and why it can’t be left to the market)   | 85         |
| 5.3      | Developing interventions to increase participation and widen access, reduce the risk of consumer harm, and mitigate negative distributional impacts | 89         |
| 5.4      | Guidelines for smart energy practitioners and commissioners: a first draft  | 92         |
| 5.5      | Recommendations to policy-makers, regulators and practitioners  | 94         |
| 5.6      | Our plans for Phase Two of <i>Smart and Fair?</i>   | 96         |
| <b>6</b> | <b>Appendix A</b>   | <b>101</b> |
| 6.1      | References  | 103        |

## Forewords

“While all the DNOs and many others have committed to various versions of the principle that ‘no one should be left behind’ in the transition to a smarter energy system, there’s still a lot of work to do to understand what that principle looks like as we start to put it into practice. We’ve supported CSE’s *Smart and Fair?* research to help build that understanding both for ourselves and others contributing this vital transition.

The results so far, detailed in this report, represent a real stride forward. The findings and tools are readily and gainfully applicable in our work and others will undoubtedly find the same. They will help to shape SSEN’s plans for the future and I hope will prove influential right across the sector as we work together on the challenge of realising an energy system which is both smart and fair.”

**Stewart Reid, Head of Future Networks at Scottish and Southern Electricity Networks**



“As the energy system gets smarter to realise the UK’s zero carbon ambitions, WPD recognises its responsibility to ensure the most vulnerable are both protected from undue impacts and supported to participate in the benefits of new services. To fulfil that responsibility, we need to know much more about the risks and opportunities involved and what it might mean for us and for others in the energy sector.

That’s exactly what CSE’s *Smart and Fair?* programme was set up to explore, which is why we are so pleased to be involved. As this report shows, CSE has delivered genuinely thought-provoking analysis which challenges us and many others to reflect in our future plans. It will enable us to reconsider the nature of consumer vulnerability in a smarter energy system and to adapt and develop new thinking, practices and services to ensure we’re fulfilling that responsibility right across our business.”

**Alison Sleightholm, Resources & External Affairs Director, Western Power Distribution**





# Executive Summary

This report sets out the results of Phase One of our *Smart and Fair?* programme exploring social justice in the future energy system.

It describes the analytical framework and associated tools that we have developed over the last year (since June 2019) to examine how the transition to a net zero energy system can be done in ways which are, as the programme name suggests, both ‘smart’ and ‘fair’. We share the findings and conclusions from our initial analysis using that framework and propose a set of guidelines for smart energy practitioners to adopt and apply. The report concludes with recommendations for initial actions by Ofgem, the Department for Business, Energy and Industrial Strategy (BEIS), energy practitioners and consumer advocates and an outline of our plans for Phase Two of the programme.

## **Background: an energy system in transition at risk of creating new ways to generate unfairness (and losing public support as a result)**

Over the course of the next few years our energy system needs to transform into a smarter, more flexible and responsive ultra-low carbon energy system. This transformation is necessary for the UK to meet its commitment to achieve net zero greenhouse gas emissions no later than 2050.

But the associated changes will massively – and potentially rapidly – disrupt the way consumers interact with the energy system. They will create demands on consumer capabilities that have hitherto been largely irrelevant to meaningful participation in the energy market.

The changes range from the widespread introduction of domestic time of use (ToU) tariffs to more specific opportunities to participate in potentially rewarding new markets which will be available through new technologies and consumer services such as domestic-scale battery storage, electric vehicles (EVs), demand flexibility, ‘heat as a service’ contracts, and local peer-to-peer trading.

These types of changes are essential to enable the cost-effective decarbonisation of the energy system. However the changes are likely to require different capabilities and attributes of consumers to participate, and so they potentially bring with them completely new ways to generate unfairness (in terms of the distribution of costs and benefits of the new system) and to leave people behind (in terms of the complexity and cost of participating in the benefits the future energy system brings).

There is a risk that, if these changes end up leaving vulnerable people behind and creating negative social impacts, public disquiet at such injustices will undermine political will to sustain the transition. The necessary progress towards a zero carbon energy system will stall.

So, to avoid this risk, how could the transition be both smart and fair?

Acknowledgement of this risk is why many actors in the energy system are espousing various formulations of the principle that ‘No one should be left behind’ in the energy system transition; that all energy consumers should have the opportunity to benefit from the transition (and thus ‘keep up’) while bearing only their fair share of the costs of change. But what, exactly, does this mean in practical terms?

- How can such a ‘smart and fair’ outcome be achieved (if indeed it can) and what would it look like?
- More specifically, what new requirements are being placed on consumers, in terms of the capabilities and attributes needed to ‘keep up’?
- How do they differ between different types of smart energy offer and service?
- Which consumers are at risk of being left behind by what sorts of offers - and how might such risks be mitigated?
- Where does responsibility lie between individual market players offering smart energy deals and regulators and policy-makers for ensuring a ‘smart and fair’ outcome is achieved?

These questions were the key focus of Phase One of *Smart and Fair?*.

## The *Smart and Fair?* Phase One objectives and approach

Our primary objective in this first phase of *Smart and Fair?* was to develop an **analytical framework and methodology** that will enable the potential social and distributional impacts of a wide range of energy market developments to be characterised and assessed on a consistent basis.

We described this as ‘greenfield’ analysis on the basis that, in our view, there was not an adequate analytical framework to get under the skin of what ‘keeping up’ would look like in the new system and who is at risk of being ‘left behind’ (and why – and what could be done about it).

In addition, there are currently a number of uncertainties in future system charging rules and potential future system value that will be available from different types of consumer action. That means it is too early to draw definitive conclusions about the potential distributional impacts of different approaches to a smarter energy system.

With these unknowns, our focus in Phase One has therefore been on creating a framework to reveal and understand the sorts of customer capabilities and attributes likely to be required by the transition to a smarter energy system and how these distribute across the household population. With that framework established (as

described in this report), we anticipate that it will prove possible to start using it to analyse the distributional impacts of different scenarios for system cost recovery and the scale and nature benefits available from different types of consumer action. This will be a key focus of Phase Two.

## Key outputs and findings from *Smart and Fair?* Phase One

In Phase One of *Smart and Fair?* we have developed an analytical framework and associated tools which can:

- Expose the full range of capabilities, characteristics and attributes which are being required of consumers to participate in and benefit from a smarter energy system, many of which are not required for participation in the current ‘pre-smart’ energy market (the **Capability Lens**).
- Enable the analysis of individual and sets of smart energy offers and opportunities to reveal the particular requirements they place on consumers (the **Offer Profiling Tool**).
- Assess the distribution of participation in different smarter energy offers and services across the consumer base, revealing the quantity, profiles and locations of consumers likely to be able to join in and benefit and of those likely to be left behind (the **Consumer Classification Model**).
- Inform consideration of the types of interventions which might be appropriate to reduce the likelihood of being left behind or reduce the impact on more vulnerable consumers of not participating.

As discussed in Section 5 of this report, initial findings from the application of this analytical framework and these tools suggest how they could be further applied to:

- Understand the distributional impacts of the transition to a smarter energy system in terms of both participation and financial ‘winners’ and ‘losers’.
- Reveal the changing nature of vulnerability in a smarter system as it changes what meaningful participation requires of consumers.
- Characterise different localities and communities in terms of the sorts of offers their residents would or would not be likely to be able to take up.

The framework and tools, through their incorporation of the concept of a technology adoption curve, can also guide thinking about how to balance the need for smart innovation and achieving a fair outcome over time (see Section 5.2).

This helps to avoid the risk of rushing to judgement about the state of ‘fairness’ of an emerging smarter energy market which requires innovation in order to get smarter (this innovation is the transition). By its nature, such innovation will inevitably

involve only a small number of ‘pioneers’ and ‘early adopters’ and carries the risks of technological failure and unrealised benefits. It therefore leaves behind at the early stages anyone who is not keen or able to participate in innovation.

Early verdicts about any disparity between who is ‘keeping up’ (a relatively small group) and who is being ‘left behind’ (everyone else) would therefore be of rather limited value and potentially unhelpful (not least because the ‘left behind’ are actually protected from the risks of participation).

Given we know early take up will be skewed like this, it would be perverse to expect or require explicit ‘fairness’ in every smart energy offer from the outset. Indeed, we will not secure a smart system if we do.

However, as a corollary, this reasoning also leads to a clear conclusion that ‘fairness’ will not reliably emerge from the market without deliberate and purposeful action by policy-makers and regulators to secure it from beyond those organisations trying to deliver smart energy offers. As described in Section 5.3, this includes:

- Designing and implementing interventions to support greater and wider participation (to reduce the numbers of ‘left behind’).
- Establishing an effective regime of consumer protection, including guidelines for all practitioners to follow.
- Ensuring there are protections for those who, in spite of such efforts, remain ‘left behind’ and unable to bear the costs of not participating.

On the basis of the work undertaken in Phase One, we can start to set out what this deliberate and purposeful action needs to look like.

We identify three different clusters of mitigation interventions which should be developed and piloted:

- 1 Interventions to support consumers by providing or making up for key missing capabilities and attributes (e.g. grants or loans for ‘smart’ technologies to make up for lack of access to capital, under-writing of technology/offer performance to reduce perceived risk of participation, access to advice to improve knowledge and support good choices).
- 2 Interventions to change the system (or an individual offer) so that some required capabilities and attributes are no longer essential (e.g. improving trust and confidence in the market, reducing minimum thresholds for participation in flexibility and demand-response services, private and social landlord regulations to require improvements or allow tenant participation).
- 3 Interventions from ‘outside’ the energy system which increase the likelihood that required capabilities and attributes are more widely available and so no

longer distinguish participants from non-participants (e.g. ubiquitous high speed broadband and high quality 4G mobile signals).

We describe a number of consumer protection measures required to maintain confidence in the market by reducing the risk of consumer harm that will emerge as the market develops – from consumers making poor choices and taking up offers which are not in their interests (i.e. mis-bought) to consumers being offered services which are not suitable for them (i.e. mis-sold) and consumers not being offered services which are suitable and advantageous for them (i.e. missed out). This includes: effective offer comparison sites and good market information; an upgrade to ‘switching’ support for vulnerable customers to include assessment of suitability for smart energy offers; a well-enforced requirement on energy suppliers to ‘treat each customer fairly’ to include which tariffs a customer is offered with a ‘right deal, right customer’ approach; and all suppliers and others offering or commissioning smart energy services to conform with the *Smart and Fair?* Guidelines (see below).

For those vulnerable consumers genuinely left behind and beyond the reach of mitigating interventions, we believe there is a strong case for a protective ‘non-participant’ tariff. Protecting these consumers from their inability to participate in the smarter energy market should be seen as a priority for policy-makers and regulators. This is to ensure that some of the most vulnerable in our society are not further disadvantaged by changes introduced to achieve a wider societal goal (decarbonisation).

We have provided draft guidelines which we believe every market participant should follow to increase understanding of the potential impacts of their offers, enhance transparency and provide good information and data on smart energy offers across the market as they come forward (see below and Section 5.4 for more detail).

As a result of the work we have done in Phase One, we have made 21 recommendations for what needs to be done by BEIS, Ofgem, energy system practitioners and consumer advocates (see below and Section 5.5). Together, these will create conditions in which the shift to a net zero energy system is both smart and fair.

## **Guidelines for smart energy practitioners and commissioners: a first draft (Section 5.4)**

We have concluded here that those offering smart energy offers cannot be expected to take by themselves all the necessary steps to ensure fairly distributed participation in their offers. Nevertheless we can set out a series of steps which those making smart energy offers to domestic consumers – or, like system operators (at grid and distribution level), commissioning or creating markets for such offers from others – should be expected to take and to document transparently and publicly.

Doing so across the market would greatly assist the development of interventions to increase market participation levels, including for vulnerable consumers. Consistent

market-wide adherence would also improve (a) the quality of listings by offer comparison sites and associated consumer suitability assessments and (b) the quality and value of future market monitoring.

---

**1. Articulate clearly the terms of your offer**

---

Including: any technology required; nature of costs and benefits (and their origins) and their relationship with responses from consumers or their equipment; risks (and their causes) of shortfall or underperformance.

---

**2. Describe the capabilities and attributes which your offer requires of participating consumers**

---

The *Smart and Fair?* Offer Profiling Tool is designed to assist this process.

---

**3. Consider and articulate how you anticipate both 1. and 2. might change over time** (e.g. within one year, two years, beyond)

---

As the offer becomes more proven and participation therefore less risky, how might the costs of participation change (for example, in terms of the price of required technology)? Are the available benefits likely to change (for example, as markets in grid services develop and mature or wholesale markets change with higher volumes of renewable generation)? How would these changes, and potentially the greater market familiarity with the type of offer, affect the capabilities and attributes required of participating consumers (e.g. available to lower income households, less dependent on attitude to risk etc.)?

---

**4a. Understand the nature and numbers of consumers who have the right capabilities and attributes required to participate in your offer now and over time**

---

---

**4b. Identify the most significant missing capabilities and attributes for those who do not, including vulnerable households**

---

The *Smart and Fair?* Consumer Classification Model (not available in the public domain) is designed to enable this.

---

**5. Describe the types of intervention which, if taken, would be most likely to enable wider participation and those which, if taken, would specifically support more vulnerable consumers to participate**

---

This can help inform the design, development, targeting and delivery of mitigation interventions across the market by whatever agencies are identified and supported to implement them.

## Recommendations to policy-makers, regulators and practitioners (Section 5.5)

On the basis of the work done in Phase One, we have identified a set of recommendations we believe will help to ensure that the shift to a net zero energy system is both smart *and* fair.

### Recommendations for BEIS

---

- 1 Working with Ofgem, ensure interventions to reduce the risk of consumer harm from smarter energy offers (as described in Section 5.3), are introduced promptly and properly funded.
- 2 Ensure that all those offering smart energy offers to domestic consumers follow the Guidelines. Require Ofgem to oversee the timely publication of the resulting information.
- 3 Support Ofgem with the introduction of a ‘Smart Energy Participation Support’ levy (raised through DNO charges) to fund appropriate interventions to enable greater participation in the smart energy market.
- 4 In partnership with Ofgem, undertake regular distributional impact analysis across the range of smart energy offers and opportunities in play or emerging in the domestic energy market, initially to predict ‘winners’ and ‘losers’ and subsequently (as more information becomes available from effective market monitoring) to reveal what is happening in practice.
- 5 Permit Ofgem to introduce regulatory oversight of third parties active in the smart energy market, including EV charging providers, aggregators of demand side flexibility services, peer-to-peer and local traders.
- 6 Support (with funding and evaluation) a programme of pilot interventions to increase take-up and widen access to participation in smart energy offers.
- 7 Ensure the prompt completion of the domestic smart meter roll-out so that this essential enabler for participation in nearly all smart energy offers is widely available.
- 8 Engage with other key responsible parties to ensure they understand and follow through on what they can do to enable wider participation in a smarter energy market, specifically for: performance standards for energy-using appliances (within BEIS); housing sector regulations and building standards (Ministry of Housing Communities and Local Government, Scottish Government and Welsh Government); broadband and mobile telecoms provision (Department for Culture Media and Sport and Ofcom).

### Recommendations for Ofgem

---

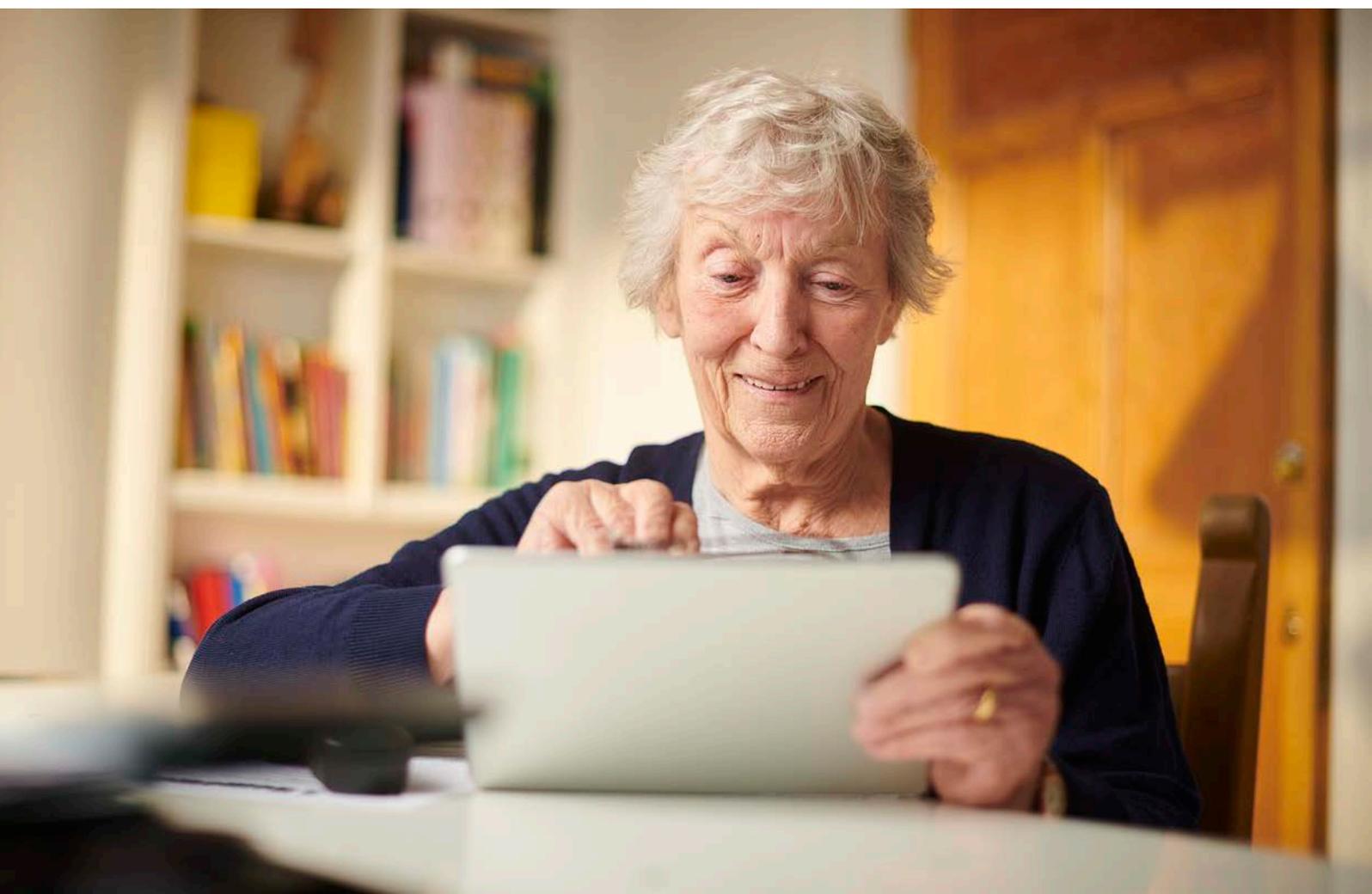
- 9 Working with BEIS and other relevant authorities (e.g. devolved nation governments), ensure the interventions to reduce the risk of consumer harm from smarter energy offers, as described in Section 5.3, are introduced promptly and properly funded.
- 10 Enforce BEIS requirement (see Recommendation 2) that all those offering smart energy offers to domestic consumers follow the Guidelines. Oversee the timely publication of the resulting information.
- 11 Clarify that the requirement on energy suppliers to ‘treat each customer fairly’ extends to offering them appropriate smart energy offers (including suitable ToU tariffs) and then rigorously monitor and enforce compliance.
- 12 Sponsor active and sustained market monitoring of the smarter energy market as it emerges, revealing who is taking up what offers (and who is not participating), the scale and nature of benefits being realised, and which consumers are receiving what support to participate.
- 13 Introduce a ‘Smart Energy Participation Support Levy’ in RIIO-ED2 funding settlement (see Recommendation 3) and encourage DNOs to use innovation allowances to design, test and evaluate interventions to enable wider participation in smart energy initiatives associated with innovative approaches to network management.
- 14 Work with energy networks, energy suppliers and consumer advocates to review how definitions of consumer vulnerability and associated risks of harm should be updated to reflect potential new risk factors introduced by the transition to a smarter energy system.

### Recommendations for energy system practitioners (energy suppliers, network operators, smart energy innovators, consumer support and advocacy agencies)

---

- 15 Follow the Guidelines and make the resulting assessments available (in line with Ofgem’s requirements).
- 16 For those advocating a smarter energy system and associated markets, acknowledge that the development of an inclusive and fair smart energy market is crucial to the long term health and legitimacy of the market as a whole. Contribute positively to its achievement. Uphold the need for ‘fair’ as well as the need for ‘smart’.

- 17 For those championing the consumer interest, ensure that the interests of current and future generations of consumers in securing the societal benefits of a smarter energy system (and the associated lower cost path to net zero carbon emissions) are reflected in advocacy for better consumer protections and interventions to enhance participation in smarter energy markets. Uphold the need for 'smart' as well as the need for 'fair'.
- 18 Actively and constructively engage with initiatives to pilot and test interventions to increase and widen participation in smart energy offers.
- 19 Contribute willingly to Ofgem-sponsored market monitoring, providing data on participation rates and the benefits and costs being experienced by different types of customer.
20. DNOs should use innovation allowances to design, test and evaluate interventions to enable wider participation in smart energy initiatives associated with innovative approaches to network management.
- 21 Consider supporting and participating in Phase Two of CSE's *Smart and Fair?* research programme.



## The *Smart and Fair?* Capability Lens (Section 2)

The *Smart and Fair?* Capability Lens is a concept designed to enhance understanding of the demands placed on domestic consumers by different smart energy offers, technology advances, and emerging energy market developments.

The origins of the Capability Lens lie in an appreciation that a consumer's (and their household's) ability, suitability, and willingness to participate in such offers and developments are dependent on both (a) the nature of the offers and developments themselves and (b) a wide range of characteristics and capabilities of the household.

By focusing on this relationship between the offers and the factors influencing a consumer's ability to engage with, participate in and benefit from them, the Capability Lens has the potential to provide new insights into:

- How the development of a smarter energy system alters what is required of domestic consumers to participate fully in the new benefits it can offer.
- Which consumer characteristics and capabilities are – or become – key to such participation (and therefore which consumers are particularly vulnerable to being left behind).
- What sorts of mitigation might be effective, either to change the offer so it is more inclusive or to address 'gaps' in consumer capabilities so that more are able to participate.

The Capability Lens was developed based on desk research and the input of more than 60 expert stakeholders via two workshops. We have used the word 'capability' to include a wide range of characteristics of the household (from socio-demographic characteristics, skills, knowledge and attitudes), the dwelling (and its potential to



accommodate change), available technology, energy usage profile (which is a product of the first two), and the locality (which may influence which smart energy offers and opportunities are available where).

The Capability Lens comprises five clusters of capabilities. Each of these comprises several specific factors, identified and refined based on existing evidence and feedback from expert stakeholders.

### **The *Smart and Fair?* Offer Profiling Tool (Section 3)**

The Offer Profiling Tool provides a framework to assess systematically the capabilities and characteristics required for households to participate in one or multiple smart energy offers. Based on the Capability Lens, the tool (an Excel spreadsheet) is currently a beta version.

Experience of using the tool to profile a smart energy offer suggests this exercise not only reveals the characteristics of those households more likely to take up an offer, it also encourages users to be more precise in their conception of the offer being considered. This is because the tool effectively ‘asks the question’ of whether any of a wide range of capabilities or attributes might be relevant to participation.

By using the Offer Profiling Tool to assess a number of different offers, it can help build up a picture of the required capabilities which are common to many offers and which ones tend to occur in combination both within offers and for individual consumers. An assessment of either individual offers or multiple offers can suggest potential opportunities for mitigation – interventions which would allow more people to participate in an offer. At a very simple level, if high speed broadband is identified as an essential requirement to take up an offer, providing high speed broadband would be an effective mitigation for those households for which that is the only ‘missing’ attribute.

User testing of the Offer Profiling Tool revealed its value as a stimulus to discussion between different people who have each assessed the same offer. Exploring the differences between each user’s offer profile can help colleagues to deepen their understanding of both the offer(s) in question and the consumers likely to participate.

### **The *Smart and Fair?* Consumer Classification Model (Section 4)**

The Consumer Classification Model has been designed alongside the Offer Profiling Tool. At its heart is a dataset in which we have (to the extent we could) matched the capabilities and offer requirements identified by the Capability Lens and Offer Profiling Tool with spatial data that represents all households (or all consumers at a household level) in England.

The Consumer Classification Model can therefore identify, characterise, quantify and locate consumers on the basis of how well they match the offer profiles produced with the Offer Profiling Tool and therefore their likely engagement with each and all these offers.

Running the model on a number of different offers reveals the types, quantity and locations of households who are most consistently able to access a range of different offers. It also reveals which consumers lack the capabilities or circumstances to engage with any of these new emerging energy system offers. Further analysis can then be conducted to reveal further information and common characteristics of these 'left behind' consumers.

By applying the concept of the Technology Adoption Curve within the model to represent a consumer's readiness to adopt a new offer or service, we allow some consideration of the timescales of adoption and how take up might grow over time. This helps to avoid snap judgements about who is 'keeping up' and who is being 'left behind' (and how fair that is) at the early stages of innovation when that will inevitably only involve a relatively small number of willing and able 'innovators'.

The Consumer Classification Model offers various analytical options. For individual offers, it can:

- Identify and map the households and dwellings who are most likely to have the capabilities required to take up, engage with or access a particular offer (based on the outputs of the Offer Profiling Tool).
- Understand the impact of mitigation options in terms of enabling additional households/consumers who miss out being in the 'most likely to engage' group of households, but only through one limiting factor.
- Produce summary statistics for any or all groups of households based on the extent of their engagement in a smart energy offer (i.e. the numbers of people likely to access an offer, and disaggregated by other characteristics such as tenure, fuel poverty, age band).

When combining offers in a multi-offer analysis, the model can also undertake the following analysis:

- Reveal which types of households or consumers are most likely to be able to participate in a smart energy system in the future based on their abilities to routinely engage with or access multiple offers analysed in the model.
- Alternatively, identify those households who are unable to access any offers assessed using the tool, and therefore reveal the group of households who are most likely to be 'left behind' by the transition to a smart energy system.

We have identified further work to validate different aspects of the model, particularly the relationship between the available household-level data chosen to represent specific household attributes and actual household data (particularly for, for example, energy use profile and demand flexibility attributes).

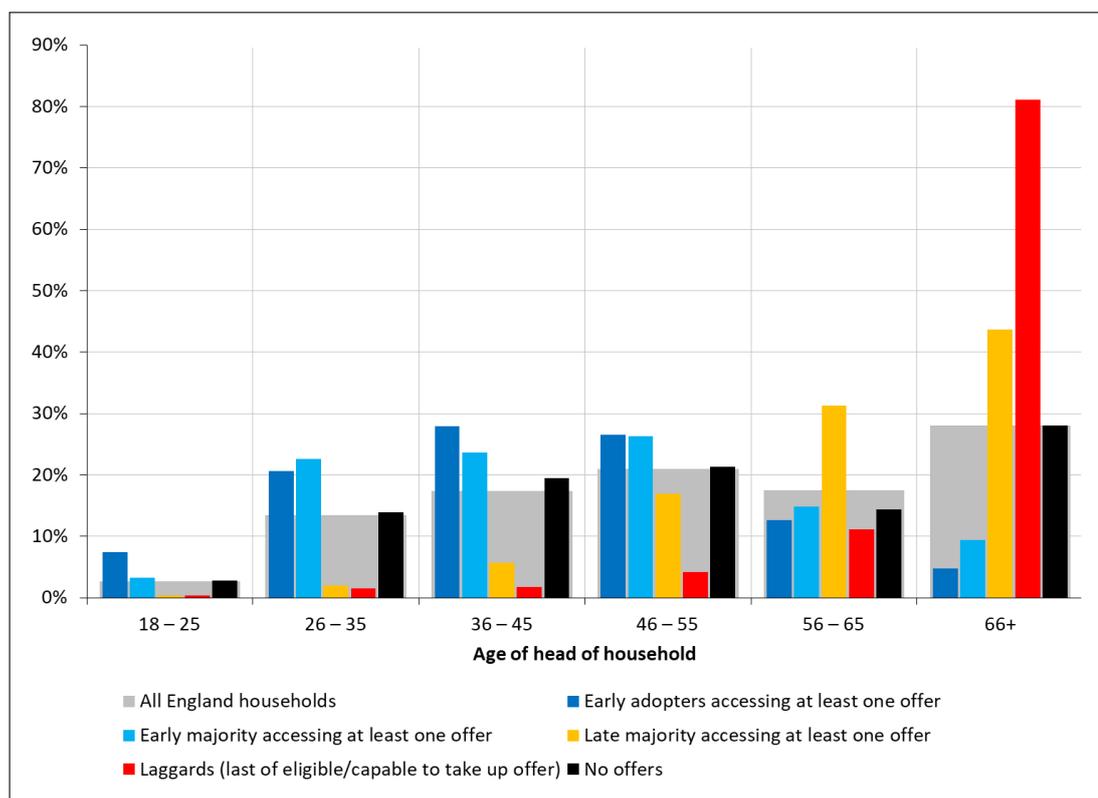
The report describes a number of illustrative examples of analysis which the Consumer Classification Model can be used to produce. These can be found in Section 4.4 of the report. Two example outputs are shown below.

The illustrative results presented in this report demonstrate the Model’s potential power in predicting whether and how different consumers will participate in the offers associated with the transition to a smarter energy system. In particular, it has the potential to reveal, profile and map the types of households who are most – or least – likely to be able to participate.

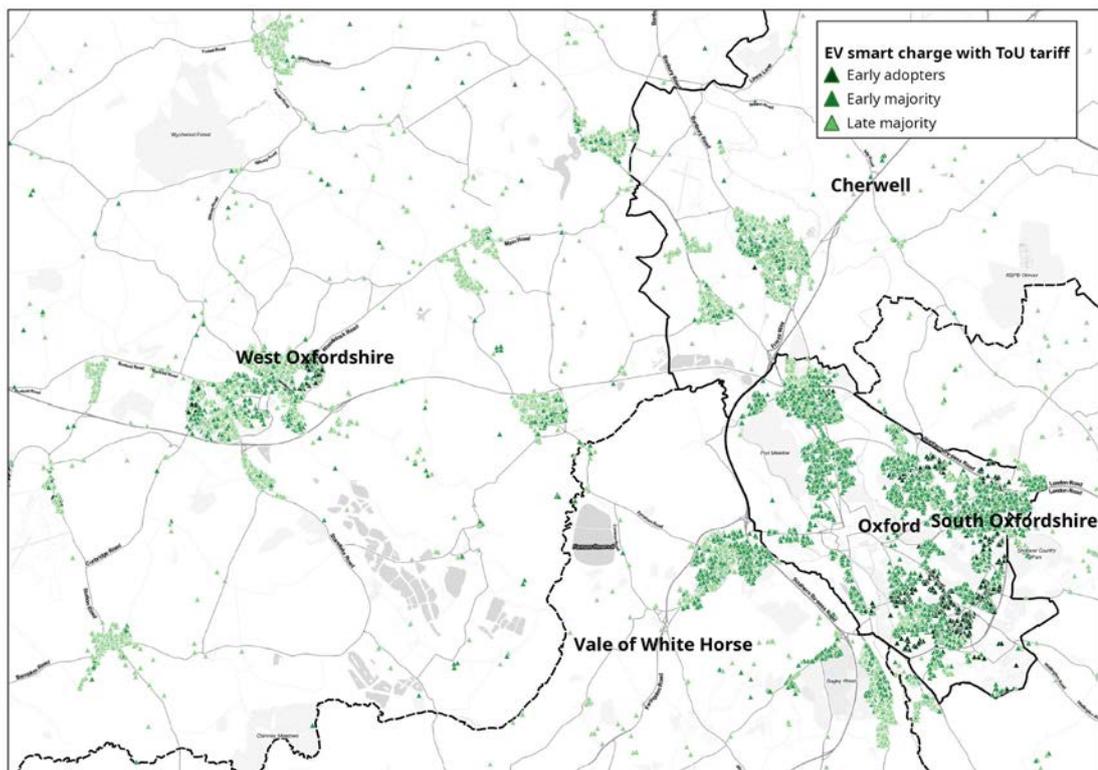
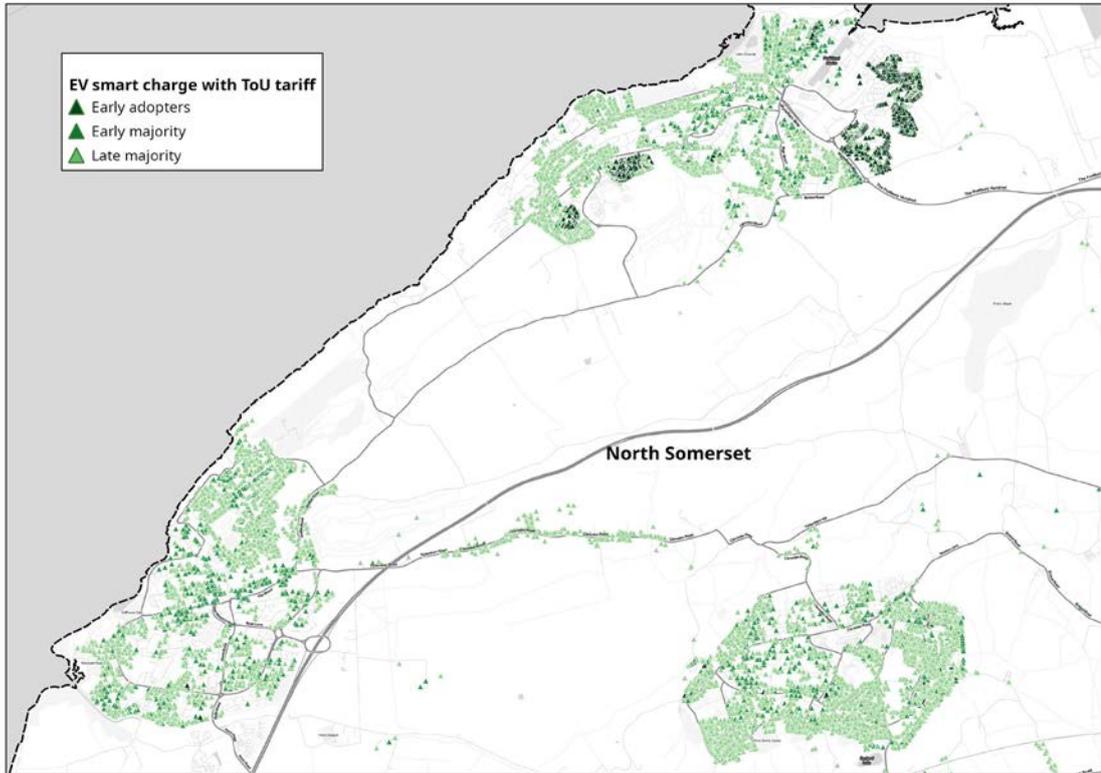
The specific results of this analysis reported here are subject to the significant caveat that they depend on the accuracy of the characterisation of the offers using the Offer Profiling Tool and of the association between attributes and consumer data in the Consumer Classification Model. This includes the positioning of consumers on the adoption curve. The analysis also assumes mitigation interventions as presented are fully effective.

Acknowledging this caveat, the results do suggest that the smart energy market with the sorts of offers currently conceived is likely to be more accessible to less vulnerable and better off households living in more urban areas. Conversely, the results also suggest that most of the households which would currently be categorised as being vulnerable are likely to be in the ‘left behind’ group who are unable to access the smart energy offers that are emerging on the market.

**Age profile of different smart energy consumer groups**



**Maps showing locations of different adopters for EV smart charging offer with ToU tariff (West of England and Oxfordshire)**



## Our plans for Phase Two of *Smart and Fair?* (Section 5.6)

Phase Two of *Smart and Fair?* will be a significantly larger programme than Phase One designed to have a valuable impact at this key moment in the transition to a smart, decarbonised energy system.

### a. Validating the outputs of Phase One

---

As the smart energy market produces more empirical evidence, we will test the validity of the ‘best available opinions’ currently embedded in the Capability Lens and Consumer Classification Model.

### b. Improving the *Smart and Fair?* analytical tools

---

**Beyond a beta version of the Offer Profiling Tool:** Alongside seeking user feedback on the beta version, we intend to design a more intuitive, accessible web-based tool.

**Improving the Consumer Classification Model:** We intend to incorporate further relevant data (e.g. network constraints) and explore how to improve characterisation of dwelling suitability for certain technologies, household energy profile, and mitigating interventions.

### c. Area profiling and offer and ‘participation support’ targeting

---

We want to test our belief that the analytical framework can be used ‘in reverse’ to develop profiles of communities in terms of their likely interests in different types of smart energy offer and the sorts of interventions which might be necessary to secure inclusive participation.

### d. Designing and piloting interventions to increase and widen participation in smart energy offers

---

To start to build an evidence base of the effectiveness of different types of intervention, we need to be involved in designing, piloting and evaluating mitigation options alongside the roll-out of specific smart energy offers (e.g. a DNO/DSO looking to pilot flexibility in particular localities or with a smart energy offer providers to test different interventions).

### e. Market monitoring and support for implementation of the ‘Guidelines’

---

The emerging market provides an opportunity to shift from the largely theoretical basis of Phase One to one based on evidence from active market monitoring, assessing smart energy offers as they come to market. Predictions derived from the Offer Profiling Tool and Consumer Classification Model will be able to be tested against actual market and consumer behaviour. We can also provide support to those following the Guidelines with analysis and information.

#### f. Distributional impact analysis

---

This analytical framework can currently predict the distribution of participation in a smarter energy market over time. With more robust data in future on the potential benefits and costs of different smart energy offers, it will be able to predict the likely 'winners' and 'losers' and the nature and scale of the impacts. Such analysis will also help set priorities for mitigating actions.

#### g. Policy guidance, insight and advocacy

---

Insights from *Smart and Fair?* can help inform better policy and regulatory practice to sustain public confidence in, engagement with and consent for a smarter energy system, including:

- The nature of consumer protection required in a smarter energy.
- The interventions required to achieve wider and more inclusive participation.
- The changing nature of consumer vulnerability as the energy system becomes smarter.
- How to protect those vulnerable consumers least likely to participate from negative impacts they can ill afford.

We anticipate working with others seeking similar outcomes.

*Please note these plans are subject to CSE securing sufficient funding to undertake the programme and its different elements.*

### Support us to deliver Phase Two of *Smart and Fair?*

If you would like to explore how your organisation could support and become involved with any of these elements of Phase Two of our *Smart and Fair?* programme, please contact:

Simon Roberts OBE, CSE Chief Executive on [simon.roberts@cse.org.uk](mailto:simon.roberts@cse.org.uk)

Jenny Mitchell, CSE Senior Development Manager on [jennifer.mitchell@cse.org.uk](mailto:jennifer.mitchell@cse.org.uk)

# 1 Introduction

The Centre for Sustainable Energy's *Smart and Fair?* research programme was established in June 2019.

The programme, as its name suggests, is exploring social justice in the future energy system. Specifically it is examining how the transition to a smarter energy system can be done in ways which both achieve the UK's net zero ambitions and align with the widely espoused principle that 'no one should be left behind'. In essence, how can this much needed transition be both 'smart' and 'fair'?

This report describes the results of work undertaken in Phase One of the programme (June 2019 – May 2020), which was generously supported by Scottish & Southern Electricity Networks (SSEN) and Western Power Distribution (WPD). The report also sets out recommendations for further work both by CSE (in our planned Phase Two of *Smart and Fair?*) and by others such as Ofgem and the Department for Business, Energy and Industrial Strategy (BEIS) as well as practitioners involved in the smarter energy system and consumer advocates.

## 1.1 **Background: an energy system in transition at risk of creating new ways to generate unfairness**

Over the course of the next few years our energy system needs to transform into a smarter, more flexible and responsive ultra-low carbon energy system. This transformation is part of a necessary process to fulfil the UK's carbon emission reduction commitments – to reach net zero greenhouse gas emissions by 2050 at the latest.

But the associated changes will massively – and potentially rapidly – disrupt the way consumers interact with the energy system. They will create demands on consumer capabilities that have hitherto been largely irrelevant to meaningful participation in the energy market.

The changes range from the widespread introduction of domestic time of use (ToU) tariffs to more specific opportunities to participate in potentially rewarding new markets which will be available through new technologies and consumer services such as domestic-scale battery storage, electric vehicles (EVs), demand flexibility, 'heat as a service' contracts, and local peer-to-peer trading.

These types of changes are essential to enable the cost-effective decarbonisation of the energy system. However, by requiring different capabilities and attributes from consumers to participate, they potentially bring with them completely new ways to generate unfairness (in terms of the distribution of costs and benefits of the new system) and to leave people behind (in terms of the complexity and cost of participating in the benefits the future energy system brings).

There is a risk that, if these changes end up leaving vulnerable people behind and creating negative social impacts, public disquiet at such injustices will undermine political will to sustain the transition.<sup>1</sup> The necessary progress towards a zero carbon energy system will stall and the country will fail to meet its legally binding climate commitments and associated international obligations.

So, to avoid this risk, how could the transition be both smart *and* fair?

Acknowledgement of this risk is why many actors in the energy system are espousing various formulations of the principle that ‘No one should be left behind’ in the energy system transition; that all energy consumers should have the opportunity to benefit from the transition (and thus ‘keep up’) while bearing only their fair share of the costs of change.

But what, exactly, does this mean in practical terms?

- How can such a ‘smart and fair’ outcome be achieved (if indeed it can) and what would it look like?
- More specifically, what new requirements are being placed on consumers, in terms of the capabilities and attributes needed to ‘keep up’?
- How do they differ between different types of smart energy offer and service?
- Which consumers are at risk of being left behind by what sorts of offers - and how might such risks be mitigated?
- Where does responsibility lie between individual market players offering smart energy deals and regulators and policy-makers for ensuring a ‘smart and fair’ outcome is achieved?
- What are the implications – for progress on the transition to a zero carbon energy system – of seeking to ensure that all consumers can ‘keep up’ or are protected in some way if they can’t?
- And who pays the price and who benefits from the transition to a smarter energy system?

---

<sup>1</sup> If this seems unlikely to you, consider the political (and associated regulatory) response a few years ago to increasing public disquiet about ‘rip off’ default standard energy tariffs which left many more vulnerable households disengaged from the energy market with significantly higher fuel bills than those regularly switching – or engaging with – their supplier. The resulting price cap – which arguably has been applied on a far wider basis than was necessary to address the injustices concerning the public (i.e. vulnerable customers rather than all customers on default tariffs) – rowed back on 20 years of political encouragement for open and competitive consumer markets for electricity and gas.

CSE established the *Smart and Fair?* research programme to explore these key questions further. Our initial thinking built on an essay by CSE's Chief Executive, Simon Roberts, entitled 'Making 'No one left behind' meaningful in our future energy system' published by Citizens Advice in December 2018 (Roberts, 2018).

## 1.2 The *Smart and Fair?* Phase One objectives

Our primary objective in this first phase of *Smart and Fair?* was to develop an analytical framework and methodology that will enable the potential social impacts of a wide range of market developments to be characterised and assessed on a consistent basis.

We described this as 'greenfield' analysis on the basis that, in our view, there was not an adequate analytical framework to get under the skin of what 'keeping up' would look like in the new system and who is at risk of being 'left behind' (and why – and what could be done about it).

Such a framework could then inform strategies to mitigate negative impacts, from improved market and regulatory design for greater inclusivity to a range of interventions to help vulnerable consumers 'keep up' by overcoming, or being protected from, adverse impacts. Such mitigations could enhance the prospects of achieving an energy system transition which is both smart and fair.

## 1.3 Our approach

To achieve this primary objective, Phase One of the programme followed a five stage process. The stages were adjusted as the phase progressed in the light of research findings and the outputs of two expert stakeholder workshops held in September and December 2019.

### *Stage 1*

Cataloguing existing, anticipated and potential opportunities for households to participate in a smart energy system and detailing for each opportunity the capabilities and attributes that consumers will need to have to be able to participate in that opportunity.

### *Stage 2*

Creating a 'capability lens' based on an assessment of the capabilities required of different types of energy consumer to participate in the opportunities laid out in Stage 1.

### *Stage 3*

Testing the outputs of Stages 1 and 2 by engaging with real-world examples of smart energy market design and project development through in-house staff workshops at WPD and SSEN.

*Stage 4*

Analysing the outputs of the previous stages to develop analytical tools to (a) assess how these opportunities determine which consumers are likely to participate in the smarter energy market and which are at risk of being left behind, and (b) suggest mitigation interventions and assess their likely impact on participation.

*Stage 5*

Consider potential pilots to test the impact of mitigation interventions and draw up a set of guidelines to shape thinking about how to mitigate negative impacts and put the principle of ‘no one gets left behind’ into practice.

The expert stakeholder half-day workshops were a critical part of stages 1 and 2, particularly given the ‘greenfield’ nature of the analysis. The participants generously: provided much needed insight on questions we were asking (for which we had yet to develop answers); identified new questions we had not considered; tested and challenged our assumptions and initial findings, and; helped us to refine and sharpen the tools we were developing.

The outputs of these stages are described in the subsequent sections of this report. Specifically:

- The identification of smart energy offers and opportunities (Section 2.2).
- The Capability Lens, capturing and clustering the full range of relevant consumer capabilities and attributes that may influence a domestic consumer’s suitability, ability and willingness to participate in any smart energy offer (Section 2).
- The Offer Profiling Tool, which enables the Capability Lens to be applied to any smart energy offer to reveal the attributes it demands of consumers in order that they can participate (Section 3).
- The Consumer Classification Model, a dataset which classifies (to the extent we found currently possible) the population (England only for now), household by household, in relation to their possession of attributes included in the Capability Lens (Section 4).
- Emerging guidelines, recommendations and next steps, drawing together the insights gained from the analysis undertaken, project team discussions and expert stakeholder and WPD and SSEN staff workshops (Section 5).

#### 1.4 Some of the key questions being addressed by *Smart and Fair?*

The scope of the *Smart and Fair?* programme ranges from developing techniques to assess individual smart energy offers to examining regulatory and policy issues associated with reducing the potential for negative distributional impacts arising from the transition to a smarter energy system.

In this context, it is important to recognise that the distributional impacts of a smarter system may result as much from rules about how system costs are charged and recovered from consumers as they do from which consumers end up taking up which offers. Of course the two are related because the charging rules can affect the scale of benefits available from different sorts of consumer action; the rules therefore shape the types and value of offers coming forward (which in turn shape which consumers take them up).

There are currently a number of uncertainties on future charging rules and about potential future system value that will be available from different types of consumer action. Our focus in Phase One has therefore been on creating a framework to reveal and understand the sorts of customer capabilities and attributes likely to be required by the transition to a smarter energy system and how these distribute across the household population. With that framework established (as described in this report), we anticipate that it will prove possible to start using it to analyse the distributional impacts of different scenarios for system cost recovery and the scale and nature benefits available from different types of consumer action. This will be a key focus of Phase Two.

To give a sense of this scope and the sorts of questions considered during Phase One of the programme, reproduced below is an extract from a presentation given to a wide range of expert stakeholders at the outset.

### What does 'keeping up' in a smarter energy system look like?

- Participating in value-earning smart energy activities such as:
  - Flexing demand to avoid peaks or match renewable energy outputs.
  - Reducing use of system by reducing demand or fitting 'behind the meter' storage or renewable energy generation.
  - Being involved with local or peer-to-peer trading.
- Participation requires:
  - 'Capabilities' (personal, financial and technical) to participate.
  - Opportunities (or offers) to participate.
  - Willingness to take the risks involved in participating.

This gives rise to the following questions:

*What are these capabilities and who does or doesn't have them?*

*What activities and interventions could support participation and where do the costs of, and responsibilities for, such 'participation support' best sit?*

### What does 'being left behind' in a smarter energy system look like?

- Contributing to system costs associated with providing benefits to others (such as network upgrades to accommodate increased EV ownership) and which your circumstances mean you yourself are unable to access.
- Not being offered by your supplier a ToU tariff which rewards your 'system-friendly' behaviours (so, in a market with domestic half-hourly settlement, someone else gets those benefits). Or being offered an inappropriate ToU tariff, given your energy demand profile.
- Not receiving from an aggregator (or your supplier) a fair share of system benefits your (or your equipment's) responses generate.
- Carrying more than your fair share of system costs as others with more suitable capabilities reduce their use of the system and exposure to charges.

These situations give rise to the following questions:

*What does 'treat your customers fairly' mean for licensed suppliers in a retail market featuring ToU tariffs and smart meter data which reveals much more?*

*How are third parties (like aggregators, auto-switching services, local energy traders etc.) regulated to ensure they have similar obligations?*

*Is regulatory action needed to ensure direct pass through to consumers of network charges in line with new charging rules?*

## 2 The *Smart and Fair?* Capability Lens

The *Smart and Fair?* Capability Lens is a concept designed to enhance understanding of the demands placed on domestic consumers by different smart energy offers, technology advances, and emerging energy market developments. It forms the basis of the *Smart and Fair?* Offer Profiling Tool described in Section 3 and it informs the *Smart and Fair?* Consumer Classification Model explained in Section 4.

The origins of the Capability Lens lie in an appreciation that a consumer's (and their household's) ability, suitability, and willingness to participate in such offers and developments are dependent on both (a) the nature of the offers and developments themselves and (b) a wide range of characteristics and capabilities of the household.

By focusing on this relationship between the offers and the factors influencing a consumer's ability to engage with, participate in and benefit from them, the Capability Lens has the potential to provide new insights into:

- How the development of a smarter energy system alters what is required of domestic consumers to participate fully in the new benefits it can offer.
- Which consumer characteristics and capabilities are – or become – key to such participation (and therefore which consumers are particularly vulnerable to being left behind).
- What sorts of mitigation might be effective, either to change the offer so it is more inclusive or to address 'gaps' in consumer capabilities so that more are able to participate.

This section introduces the Capability Lens and explains the process of developing it, including the evidence justifying the inclusion of its different elements and the input of expert stakeholders. As it makes clear, we have used the word 'capability' to include a wide range of characteristics of the household (from socio-demographic characteristics, skills, knowledge and attitudes), the dwelling (and its potential to accommodate change), available technology, energy usage profile (which is a product of the first two), and the locality (which may influence which smart energy offers and opportunities are available where).

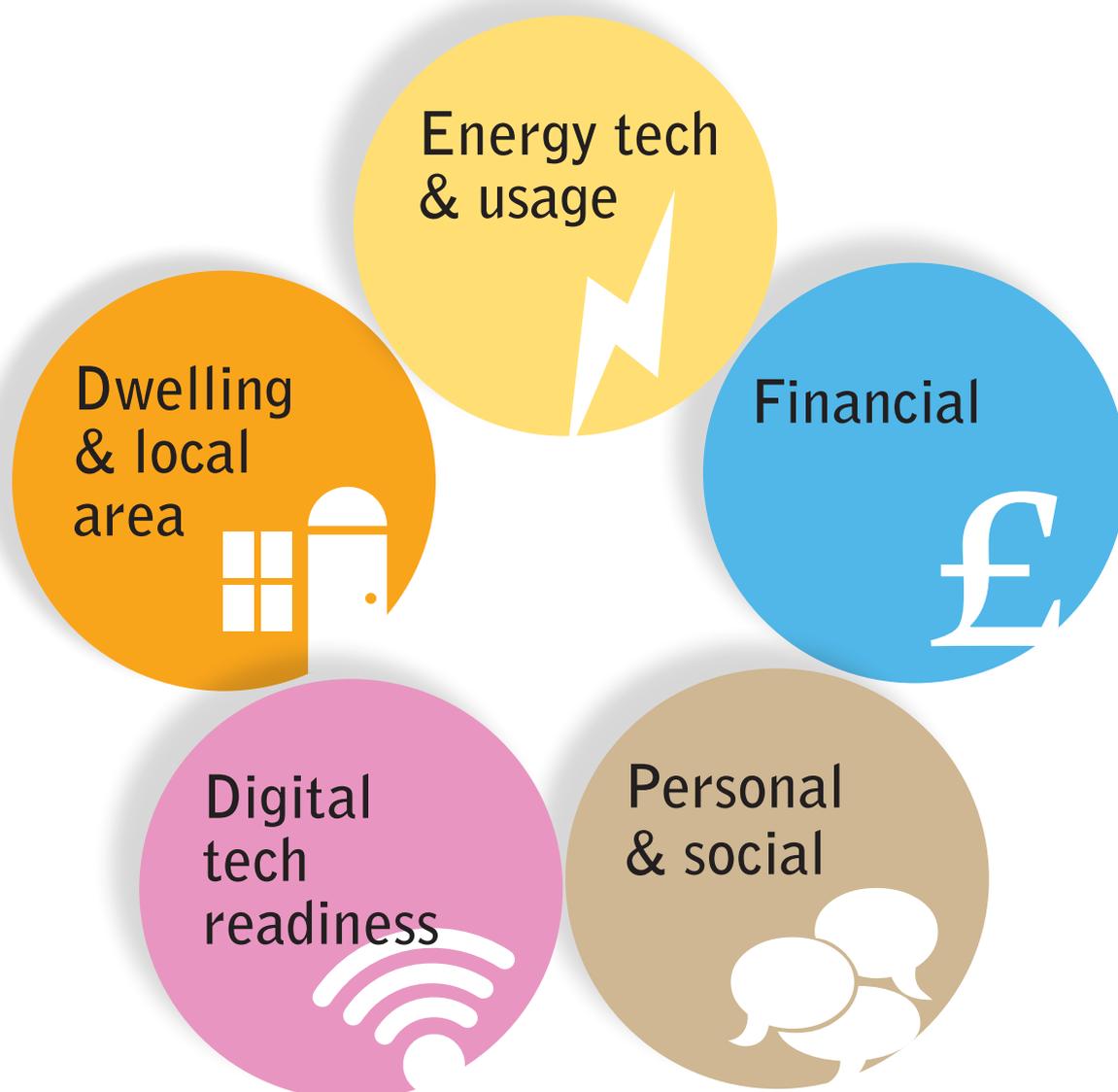
## 2.1 The Capability Lens clusters

The Capability Lens comprises five clusters of capabilities, as shown in Figure 1:

Each of the five clusters comprises several specific factors, identified and refined based on existing evidence and feedback from stakeholders. An overview of each capability cluster is provided in Table 1.

The full Capability Lens mindmap, showing all factors is illustrated in Figure 2 (page 32).

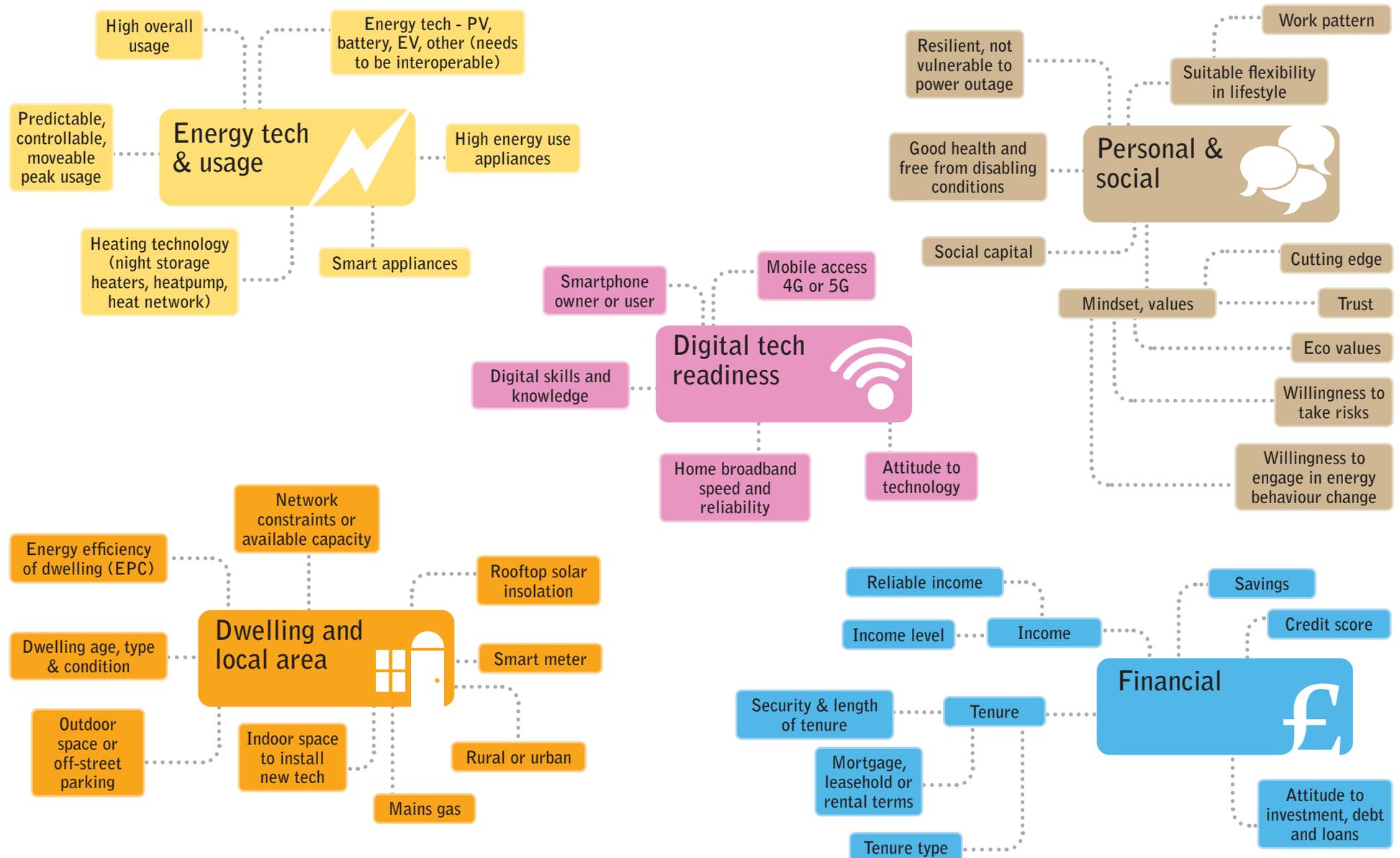
**Figure 1: The *Smart and Fair?* Capability Lens reveals an extensive range of consumer capabilities and attributes required to participate meaningfully in smart energy**



**Table 1: Summary of the 5 capability clusters**

|  | Capability cluster      | Explanation   |
|--|-------------------------|---|
|  | Dwelling and local area | <p><i>The suitability or readiness of a dwelling in its location for the occupant to participate in an opportunity which offers electricity system benefits.</i></p> <p>A smart meter at the property is a likely precondition for participation in most opportunities</p>  |
|  | Energy tech and usage   | <p><i>The appropriateness of a household's energy usage profile and existing energy technology and appliances to enable them to participate in and benefit from an offer.</i></p>   |
|  | Digital tech readiness  | <p><i>The digital technology hardware and connectivity, skills readiness and level of digital engagement of a household to enable them to participate in, and benefit from opportunities.</i></p> <p>Some, but not all, opportunities will require use of apps and other forms of digital technology, including use of multiple devices in combination.</p>   |
|  | Financial               | <p><i>The financial status and money-managing and decision-making skills required to engage in an opportunity.</i></p> <p>Access to savings, disposable income and having a good credit score will facilitate upfront investment or ability to access credit or take on lease arrangements and commit to longer term ongoing costs and services. Tenure status is likely to be a factor influencing ability to achieve payback. People's money management skills and attitude to finance is likely to affect their readiness to consider opportunities.</p> |
|  | Personal and social     | <p><i>The personal factors, mindset, values, social connections and living circumstances that enable a consumer to hear about, trust and engage in an opportunity and be able to make appropriate behaviour changes.</i></p>  |

Figure 2: Capability Lens as a mind map



## 2.2 How was the Capability Lens developed?

There were a number of steps involved in developing the *Smart and Fair?* Capability Lens. The first involved desk research to identify potential smart energy 'offers' and opportunities and draw out issues associated with consumer participation which had already been considered.

We undertook initial desk research to get abreast of how the energy system is predicted to change in the future and the implications for changing opportunities for consumers to be involved. It also enabled us to get an overview of the range of different types of technologies and offers that are likely to play a part in the transitions to a smart, low carbon energy future. In doing so, we gradually developed our own understanding of how different technologies might be used in combination, how they could respond to different types of system needs, and how those system responses correspond (or not) to delivering benefits to participating consumer households.

The National Grid's Future Energy Scenarios (National Grid, 2019) provide an overarching descriptive framework of how, in four future worlds, the energy landscape will change, making use of different combinations of technologies and requiring different levels of active participation by consumers. The changes look towards how the UK's then carbon reduction target (of 80% by 2050) could be met and included sensitivity analysis of how net zero carbon emissions could be achieved by 2050. The Community Renewables scenario envisages household uptake of digital solutions to manage energy demand, electric vehicles and smart vehicle charging (vehicle to grid and vehicle to home), domestic energy efficiency retrofits, widespread low carbon heating adoption (heat pumps and district heating), thermal storage and domestic battery storage. The net zero target would require the most significant behaviour change alongside technology and infrastructure development, incorporating the types of changes in domestic energy arrangements identified in the Community Renewables scenarios as well as large scale changes in the industry and commercial sector.

Other perspectives on future energy scenarios included analysis (UKERC, 2019) identifying demand side management and response and smart electricity networks as important to enable greater diffusion of renewables. Low cost battery storage technology and low cost renewables were identified as likely to have a significant part to play. The UKERC study criticises the tendency of scenarios not to capture adequately the potential for, and possible impact of, disruptive or discontinuous change; it recommends use of hybrid qualitative scenarios and quantitative energy system models to address this weakness.

The Open Worlds Future Network consultation document (ENA, 2018) sets out how different market, organisational and operational structures may access and utilise a range of flexible distributed energy resources to operate the transmission and distribution systems. An initial impact assessment considers how this might differently affect consumers, including how costs are shared relative to benefits. It includes consideration of domestic ownership of flexible appliances (e.g. EVs), time of use (ToU) tariffs and contracted flexibility services, including demand shifting (ENA,

2019). It notes that price signals may require social policy mitigation for consumers unable to shift demand.

Academic papers, reports from innovation trials and industry reports proved fruitful in setting out how different technologies might be packaged up and offered to consumers. Key references include BEIS and Ofgem, 2017; Demski et al., 2019; ENA, 2019; Moretti et al., 2016; Shakoor et al., 2017; Sovacool, Lipson and Chard, 2019.

Market monitoring, including a review of the websites of known innovators, recent market entrants and existing market players, also yielded information on offers already introduced into the market or being developed, piloted or market-tested (see those listed in Energy Systems Catapult, 2019).

Recent research conducted and commissioned by Citizens Advice explored the consumer journey in a world of smart energy products and services in the future and identified findings on how markets and regulations need to change to meet the needs of consumers (Arran and Marshall Cross, 2019; Crisp and Kruja, 2019). It identified digital exclusion, financial barriers, issues around consumer engagement and trust, and barriers relating to housing characteristics and tenure as affecting the ability of some consumers to participate in offers. It also highlights potential consumer risks for participants.

The review of offers identified various ways of organising technologies, services and offers which may be aimed at the domestic market but also generate benefits for the energy system and support policy goals of decarbonisation. Energy Systems Catapult have since produced a reasonably comprehensive Digital Landscape which identifies the providers of a range of consumer services, digital platforms and asset operations and data services, with links to service provider websites (Energy Systems Catapult, 2019). This landscape is shown to include a diverse range of players, including licensed energy suppliers, utility bundlers and auto-switchers, aggregators, kit manufacturers, leasers and retailers, trading platform providers and asset management service providers.

The range of different types of offers identified in the review, drawing on evidence from industry, government, academic and professional organisation sources include:<sup>2</sup>

- Energy as a service (heat or leased battery)
- Time of use tariffs (fixed, dynamic)
- Energy price comparison services and auto-switching
- Energy efficiency and renewables retrofit services
- Peer to peer energy trading
- Domestic smart heat and energy controls or management systems
- Vehicle to grid (V2G) and vehicle to home (V2H) related offers
- Aggregator services (so far aimed at commercial sector)
- Smart local energy grid and virtual power plant

---

<sup>2</sup> See 6.1 References for key sources of information and individual documents included in the review

This literature and market review revealed the range of offers and potential opportunities in a smarter energy system. As outlined below, it also enabled us to identify the wide range of consumer capabilities and characteristics that were likely to be called upon as consumers started to participate in that system. These became 'candidate' capabilities for the Capability Lens.

## 2.3 Candidate capabilities identified

The candidate capabilities identified are described below in the clusters taken forward to the next phase of developing a classification tool.

### a. Personal & social

---

This cluster of factors reflects a recognition that individual consumers' own personal characteristics, their health or disability status, family circumstances and their values and attitudes will influence if and how they become aware of offers. And it will shape their ability to participate in offers and to make behaviour changes which enable them to achieve benefits. The views and situation of others in the household, as decision-makers, dependents and users of energy will also have a part to play. It recognises that people's social capital comprising their connections with family, friends, social media engagement and engagement in groups or other networks is likely to influence awareness and uptake of offers. This reflects models of the social determinants of health, which recognise individual factors, lifestyle and social networks as the most immediate factors shaping health outcomes for an individual. Similarly, behavioural change models place the physical, psychological and social factors at the core of behavioural change (SRHIE, 2010; Michie, van Stralen and West, 2011).

Socio-demographic factors, such as gender, ethnicity, level of education/qualifications, household size and socio-economic status may be associated with patterns in the possession of capabilities associated with uptake of offers. This is a gap in the available evidence. A study on the uptake of renewable energy technologies observed which attitudinal factors are prevalent in a particular better-off social grouping within which early adopters live (Elmustapha, Hoppe and Bressers, 2018).

#### *Resilient/not vulnerable to power outage*

Innovation trials in the electricity sector have been cautious of permitting people who require electricity-dependent medical equipment for their health to participate, because of the potential risk of faults with new technology (see e.g. UKPN, 2019). This also applied during the early stages of the smart meter rollout (Consumer Futures Unit, 2016). Early in the development of a smarter energy market, it is likely that any household which relies on electricity-dependent medical equipment (or for any other reason may struggle to cope with power outages) will not be invited or permitted or be willing to participate in adoption of new technology. Even once the risks are considered lower, they may be less able to benefit from certain offers if they rely on a continuous steady supply of electricity. However, it may be that if this requirement is minimal, there remains scope for them to be able to flex their use of power for other purposes.

In the early adoption stages, it is likely that participation is exclusively amongst households who are ‘resilient/not vulnerable’. There may be consumer risks associated with mis-selling of offers to people who are vulnerable to power outage (Crisp and Kruja, 2019).

Pre-payment meter customers were also identified as potentially vulnerable to self-disconnection, risking harm to themselves if they are not able to flex their energy usage in a way that enables them to take advantage of time slots of low cost electricity or, more crucially, to avoid usage during periods of peak cost. This is likely to correspond with low income but having a pre-payment meter makes self-disconnection more straightforward (i.e. no top up = no gas or electricity), whereas it would be more effortful (though still desperate) for credit customers (i.e. need to turn everything off) (Crisp and Kruja, 2019; UKPN, 2019).

#### *Good health & non-disabled*

Poor health or disability are associated with below average income, increased risk of unemployment, increased rates of fuel poverty and use of prepayment meters, greater likelihood of being at home for more time in the daytime and above average energy needs relating to their health condition (SRHIE, 2010; Snell, Bevan and Thomson, 2014). It is inferred that particularly early in the adoption curve, people with long term health conditions or disability may be deterred by the financial risks and technology uncertainties associated with new offers. However, the benefits offered by certain offers may be particularly attractive to or valued by people with specific health conditions or disability (and their carers or wider household) where they provide greater certainty over expenditure and could offer benefits for safeguarding, independent living and quality of life. For example, a heat as a service offer with strong inclusive design credentials could provide a guaranteed level of warmth for a specified cost and enable improvements to the energy efficiency and increased control of heat within the home (Arran and Marshall Cross, 2019.)<sup>3</sup> Similarly, disabled people who can lease an electric vehicle (EV) using their mobility allowance may be able to achieve valued convenience and financial benefits from offers that help with the cost of installing a domestic EV charging point and low cost vehicle charging.<sup>4</sup>

#### *Suitable flexibility in lifestyle*

Time of use tariffs offer benefits for consumers who are able to adjust their energy usage to meet system needs – for example, to minimise usage at peak times or to use electricity at times when renewable generation risks exceeding demand. Some consumers and households are likely to already have daily routines which fit reasonably well with what is needed by networks. Others may be able to adjust their usage through automation or conscious choices. However, some households will not have the same flexibility to respond to system needs. Households identified as likely to experience

---

<sup>3</sup> See e.g. [www.bristol-energy.co.uk/bristol-energy-first-uk-supplier-trial-heat-service](http://www.bristol-energy.co.uk/bristol-energy-first-uk-supplier-trial-heat-service)

<sup>4</sup> See [www.uca2magazine.co.uk/motability/electric-cars-disability](http://www.uca2magazine.co.uk/motability/electric-cars-disability)

limited flexibility or unsuitable usage patterns include families with pre-school aged children, shift workers, complex or large households including multi-generational families, home-sharers or large families: those who already self-limit their usage as much as possible may be particularly disadvantaged (Arran and Marshall Cross, 2019). People with health conditions or disabilities may also have limited flexibility (Arran and Marshall Cross, 2019). People who work full-time may also face constraints in their ability to limit their peak-time usage. Smart appliances and home management systems which enable automation may enable some flexibility constraints to be overcome. Homeworkers and retired people may have relatively greater flexibility to adjust usage through the day, though this will interact with the extent of their willingness to change.

#### *Mindset & values (Cutting edge; Trust; Eco values; Attitudes to risk and change)*

Mindset and values are likely to shape willingness to adopt new offers and to make behaviour changes to benefit from them (Elmustapha, Hoppe and Bressers, 2018; Nicolson, Fell and Huebner, 2018; Hubert et al., 2019). Favourable mindset and values are identified as valuing cutting edge technology and services (or novelty-seeking), independent judgment making, willingness to place trust in suppliers or service providers, eco-values, willingness to take risks and willingness to change behaviour or practices (ETI /ESC, 2015; Nicolson, Fell and Huebner, 2018; Arran and Marshall Cross, 2019; Crisp and Kruja, 2019; Sovacool, Lipson and Chard, 2019). A consumer's mindset and values are likely to be shaped by or be associated with multiple other factors in the Capability Lens, including income, tenure type, health and disability condition and social capital (Nicolson, Fell and Huebner, 2018). A limitation of the existing empirical evidence is that it is mostly based on either stated preferences (which can be unreliable predictors of actual uptake) or are based on likely skewed samples favouring better-off early adopters (Elmustapha, Hoppe and Bressers, 2018; Nicolson, Fell and Huebner, 2018).

#### *Social capital*

People's social capital comprise their connections with family, friends, social media engagement and engagement in groups or other networks. These are likely to influence awareness and either encourage or discourage uptake of offers (Elmustapha, Hoppe and Bressers, 2018; UKERC, 2019; Office of National Statistics, 2020). Certain forms of social capital may help overcome shortcomings in other capability factors or to influence personal attitudes of trust and willingness to change behaviour. Social connections can help individuals access opportunities, find ways around blocking factors and can influence the pace of uptake (Gregg et al., 2020).

### **b. Energy tech & usage**

---

A household's energy usage patterns will directly influence the extent to which, and the ways in which, they can benefit from participating in an offer. This includes peak and high energy usage by the household, what appliances they already own and any energy technologies already installed or owned, such as rooftop solar PV or an electric

car. Where a consumer already has certain technologies, this may make the case for taking up an offer more attractive, though technology compatibility factors will require consideration (Citizens Advice & ESC, 2018; ENA, 2018; Arran and Marshall Cross, 2019).

#### *Overall usage (high)*

An existing high overall energy usage is likely to be associated with a greater opportunity to benefit from offers, since greater savings will be achievable and there is likely to be greater scope to flex non-essential usage. Opportunities for energy demand reduction, with associated financial savings, will be more worthwhile. Whereas consumers with low overall usage, particularly those who already ‘underuse’ energy relative to their needs, notably consumers in fuel poor homes, may have limited flexibility to adjust their usage.

#### *Predictable, controllable, moveable (high) peak usage*

Reducing peak usage is a valued system service which consumers participating in offers are likely to be rewarded for. To be of value, high peak usage needs to be predictable, controllable and moveable. Consumers with high usage generally are also likely to have high peak usage. One study found that household size and heat source are useful predictors of higher moveable electricity consumption during peak hours and potential level of response (Edwards, 2019). Those able to benefit most will be those willing and able to curtail or shift to a different time, likely using automation. This item was refined based on input received in the first stakeholder workshop.

#### *Heating technology*

Certain forms of heating technology are likely to be compatible with new offers, including newer night storage heaters and heat pumps. Newer homes fitted with heat-pump or heat-network ready heating systems should prove more straightforward to get ready to install next generation low carbon heating technologies (Arran and Marshall Cross, 2019; ETI /ESC, 2019).

#### *Interoperable electricity generation and storage technologies*

Consumers who live in homes with compatible types of rooftop PV, batteries, or other technologies, including newer hot water tanks are likely to take a lead on uptake of appropriate offers and capture the system benefits their flexible use can offer. Those who already have these installations will have a ‘head start’. However, it is likely that offers will come forward offering installation of these new technologies (combined, for example, with leasing or financing and tailored tariffs). This means that the current presence of such technologies in a home will be less important (though obviously households who already have these technologies are themselves unlikely to participate in such offers).

### *Electric vehicle ownership*

Consumers who already own an electric car or van are likely to recognise the benefits of appropriate tariffs or other offers which allow them to reduce the cost of charging their car and be rewarded for charging at off-peak times and possibly discharging the battery for use in the home at peak times (Arran and Marshall Cross, 2019; Sovacool, Lipson and Chard, 2019). The point made under ‘Interoperable electricity generation and storage technologies’ above is also relevant here. Having the technologies already may not give that much of a head start in this instance: offers are already appearing which provide the EV on a lease arrangement rolled up with electricity ToU tariffs and smart charging conditions.

### *Appliance ownership*

Consumers who own smart appliances, such as dishwashers, washing machines or fridges are more likely to be able to benefit from time of use tariffs that reward flexible usage, particularly where this flexibility can be automated. The ownership of high energy usage appliances (including non-smart appliances) may be useful for consumers able and willing to flex their usage patterns manually to gain rewards (e.g. use the washing machine at a time when electricity is cheap). By contrast, homes with few appliances - or older, inefficient ones - may find time of use tariffs unattractive, particularly if they are unable to avoid peak usage (Arran and Marshall Cross, 2019; Edwards, 2019; Sovacool, Lipson and Chard, 2019).

## **c. Dwelling & local area**

---

The ability of a consumer to benefit from offers is likely to be enhanced or limited according to characteristics of their dwelling (or home) and the local area they live in.

### *Energy efficiency of dwelling (EPC)*

The energy efficiency of a dwelling affects total energy usage. Very inefficient dwellings cost more to heat and use more electricity than average. Where it is costly or technically difficult to achieve energy efficiency improvements, this may reduce how far a consumer can benefit from offers. However, certain offers, such as whole house retrofits or ‘heat as a service’, may be particularly well-suited to energy inefficient homes. Very efficient homes may be more suitable for certain offers, though there may be reduced opportunities to save money if energy costs are already very low (Bankovskis, 2017; Citizens Advice & ESC, 2018; ETI /ESC, 2019).

### *Dwelling age, type and condition*

As noted above, the age, type and condition of a dwelling will shape what offers are suitable (Arran and Marshall Cross, 2019). Newer homes are more likely to be fitted with or be compatible with the relevant technology whilst specialist offers may be able to overcome the energy challenges associated with historic homes, solid wall homes, high rise buildings, off gas homes and other hard to heat or hard to retrofit homes.

### *Outdoor space including off-street parking*

Certain offers will require sufficient external space for associated technologies or for charging electric cars. This includes some heat pumps. Larger detached and semi-detached homes, particularly in towns, villages and suburbs may therefore be more suitable for such offers. Communal or non-domestic solutions may offer alternative solutions for consumers but this may narrow their choice of suitable offers. The question of the availability of suitable parking plots (for EV charging) was explored in the English Housing Survey Energy Report 2017 – 18 (Citizens Advice & ESC, 2018; MHCLG, 2018; Arran and Marshall Cross, 2019; Sovacool, Lipson and Chard, 2019).

### *Indoor space to install new technology*

Likewise, certain offers will require sufficient indoor space in which to install associated technologies, including batteries, hot water storage tanks, heat pumps, hydraulic interface unit (HIU) as well as associated pipework and display units. Larger homes and some older homes with larger floor areas are more likely to be suitable (Arran and Marshall Cross, 2019; ETI /ESC, 2019).

### *On mains gas*

For certain heat services, being on mains gas may be beneficial, such as for installation of hybrid heating systems or other future heating systems that use the existing mains gas network. However, in future being on mains gas may be an indicator of a need to access services for shifting to electric heating systems (MHCLG, 2018; Arran and Marshall Cross, 2019; ETI /ESC, 2019). Dwellings with electric heating may have more scope to shift peak demand, including possible use of night-storage heaters, where systems are in place for residents to share in the benefits of such flexibility (Edwards, 2019).

### *Rooftop solar insolation*

For offers which involve domestic solar PV generation and storage of renewable electricity, having a dwelling with a suitably sized roof with a suitable aspect will be advantageous. Of these, more southerly homes (with higher insolation), detached, semi-detached or terraced homes are more likely to be suitable as compared to dwellings in high rise buildings or lower floor flats (Sovacool, Lipson and Chard, 2019).

### *Rural/urban*

A rural or urban location is likely to influence suitability for particular offers. Urban locations are likely to be more favourable for offers which require 'at scale' connections to bring down installation or running costs or achieve a suitable scale of flexibility within a given area of network constraint and to ensure that suitable maintenance specialists are available. A rural location may be more favourable for offers which require more space, which relate to localised renewable generation or which respond to the specific challenges of improving energy efficiency in rural hard to heat homes (Arran and Marshall Cross, 2019; Sovacool, Lipson and Chard, 2019).

### *Network constraints or available capacity*

Offers which relate to renewable generation may be more favourable in areas with good network capacity whereas offers which relate to demand reduction may be more attractive in areas with network constraints. This may relate to a given sub-station or to a larger network area (ENA, 2018).

### *Smart meter*

Having a smart meter to record half-hourly electricity usage and enable visibility to the consumer and service provider is likely to be essential to nearly all offers. Some offers may include installation of a smart meter. Homes with technical barriers to having a smart meter fitted and communicating properly will be unable to participate in most offers (Bristol Energy, Innovate UK and Regen, no date; SSE, 2017; Crisp and Kruja, 2019).

## **d. Financial**

---

The financial capability of the consumer is likely to be important to the ability to take up offers, with better-off households more likely to be able to take up and benefit from them. This is because they may involve buying equipment, having a credit score sufficient to lease equipment, or being financially resilient enough to take a risk of an innovative approach that might fail. Other financial factors will also be important (Crisp and Kruja, 2019; ENA, 2019; Sovacool, Lipson and Chard, 2019).

### *Household income*

Having a high or above average income is likely to be a key capability to influence the likelihood of a consumer being targeted for such offers and in turn their ability to afford to take up offers that may require upfront investment, ongoing fees or costs or a degree of financial risk. Lower income households are likely to struggle to afford costs or be willing to risk taking out loans or signing up to long term contracts. However, in line with the technology adoption curve, it is likely that, over time, an increasing number of offers will be developed that suit a wider range of income levels and where perceptions of (and actual) risk reduce with greater take up (Nicolson, Fell and Huebner, 2018; UKPN, 2019).

### *A reliable income*

Having a reliable income is likely to be an important consideration for consumers being willing to sign up to longer term contracts or to make upfront investments that require regular fixed repayments. Full time employees, self-employed and contractors with reliable income streams and households with regular income from investments are more likely to rely on their income to cover such payments (Arran and Marshall Cross, 2019).

### *Tenure type*

Home owners are likely to be more able to make the financial decision to take up longer term offers or offers that require investment in the dwelling or changes to the fabric

of the property. Private tenants may be able to participate with the agreement of the landlord, though some offers may not be suitable. Social tenants may be able to achieve cost-saving benefits or rewards in the form of increased comfort, but certain offers may only be available if their landlords consent to, or arrange for their participation (Arran and Marshall Cross, 2019; ETI /ESC, 2019; Sovacool, Lipson and Chard, 2019).

#### *Security and length of tenure*

For home owners and particularly for tenants, the willingness and ability to participate in offers is likely to be shaped by how long they will be living in a given property. Tenants on longer leases and owner occupiers who expect to stay put for some years are more likely to benefit from those offers which require significant upfront investment and yield rewards over a longer term period (Citizens Advice & ESC, 2018).

#### *Mortgage, leasehold, rental and insurance terms*

Consumers with a mortgage or leaseholders or tenants may find that the terms of their mortgage, leasehold or tenancy restrict what measures they are permitted to undertake; these terms may prevent them from engaging in certain offers. Freeholders and those who own their home outright are likely to have access to the widest choice of offers, whilst those with mortgages or leases are likely to be able to undertake some measures only with the agreement of their lender or leaseholder. Re-mortgaging may provide a way for some people to access upfront investment. Insurance terms may be a limiting factor for some consumers seeking to take up certain offers that involve changes to the terms of their insurance. This was an item explored and broadened in the expert stakeholder workshops.

#### *Savings and investments*

Having access to savings to pay for up-front investment or as a fund to cover any unforeseen costs is likely to favour participation in offers (Financial Conduct Authority, 2017; Crisp and Kruja, 2019).

#### *Credit score*

Some offers involve long term contracts or loans. Applicants with a good credit score are more likely to be able to take up offers on favourable terms. For people with limited savings or lower income, a good credit score may enable participation, overcoming other financial barriers (Crisp and Kruja, 2019; Sovacool, Lipson and Chard, 2019).

#### *Attitude to investment, debt, loans*

With an overlap with attitude to risk, consumers who are more confident about taking out a loan or making an upfront investment are more likely to take up offers which involve such transactions (Elmustapha, Hoppe and Bressers, 2018).

### e. Digital tech readiness

---

Most offers will involve new forms of technology and some will require control or user engagement via an app, website or in-home device or use of an online trading platform. However, some offers may automate controls, avoiding the need for the consumer to actively engage with technology and in some cases removing the need to use existing poorly-understood controls, such as heating programmers (Citizens Advice & ESC, 2018; Elmustapha, Hoppe and Bressers, 2018; Crisp and Kruja, 2019).

#### *Smartphone ownership or usage*

Smartphone ownership is likely to be important to many offers which involve the use of apps to engage with platforms, control services or communicate with providers. Other technology, including PCs, laptops and tablets are also likely to be important. Rates of ownership of smartphones are now very high in the UK, though the older age groups have lower levels of uptake (Ofcom 2020).

#### *Digital skills and knowledge*

Associated digital skills, knowledge and a confident attitude to technology will enable uptake of offers and ability to engage with and gain benefits from offers (Hardy, 2017; Crisp and Kruja, 2019). Simple interfaces and automated controls will reduce the level of skills and knowledge required to participate in offers (Lloyds Bank, 2019).

#### *Attitude to technology*

Existing confidence in using multiple forms of technology, including smartphones, PC and web-based platforms will be beneficial to participation in most offers, which may include installation of new technology, require use of programmers or other controls and may require user action to get different technologies talking to each other (Arran and Marshall Cross, 2019).

Accessible technologies provide opportunities to enable participation by a wider range of people, overcoming other barriers and potentially making services more suitable for people with sensory or intellectual impairments (Arran and Marshall Cross, 2019).

#### *Broadband and mobile data access, speed and reliability*

Sufficient reliable broadband and/or mobile access will be required for many smart energy services to be delivered reliably. As more of the country gets decent broadband and mobile coverage, this should enable most households to participate (Arran and Marshall Cross, 2019).

## 2.4 Limitations of the evidence

The evidence underpinning the Capability Lens is often reliant on descriptive data about consumer, household and dwelling characteristics, inferences from other sectors, expert views, unverified claims from commercial small-scale trials, and academic empirical studies which are too small to achieve statistically significant differences in uptake to draw robust causal inferences and which often involve participants from a narrow social range. A systematic review focused on consumer demand for time of use electricity tariffs highlights the shortcomings even for generating accurate estimates of likely overall rates of uptake, never mind determining the distribution of take up and of resulting costs and benefits (Nicolson et al., 2018).

The Capability Lens has been constructed and tested with the active involvement of stakeholder experts, drawing on the insights of academics and industry specialists who have themselves commissioned or directly undertaken related research or industry trials. The lens combines insights from economics, behavioural science, and socio-technical disciplines.

## 2.5 Prototype to beta version – stakeholder workshops

Drawing on this evidence, a prototype Capability Lens was produced, visualised as a mind-map of clusters of capabilities identified as potentially relevant to different types of smart energy offers and their take-up by domestic consumers (see Figure 12 in Appendix).

A prototype mind-map model was presented and tested at a first stakeholder workshop attended by 45 energy sector stakeholders in September 2019 held at the ENA office in London. Following presentation of the *Smart and Fair?* approach, stakeholders worked in groups to test out the prototype model against 8 example smart energy type offers.

Feedback gathered during the first stakeholder workshop was then used to inform production of a revised beta version of the Capability Lens. This involved addition, removal, renaming and reassigning between clusters of individual capability items (see Table 9 in Appendix for a summary of the changes made).

The beta version of the Capability Lens was subsequently presented to 25 energy sector stakeholders at a second invited expert stakeholder workshop in December 2019 and at internal workshops for SSEN and WPD staff in January 2020.

Feedback for further consideration from the two invited energy stakeholder workshops raised attention to the need to acknowledge and understand the dynamic and inter-relating nature of capabilities, recognise and ideally respond to wider shaping factors (policy, regulatory) in the current and future energy landscape. A further area of interest concerned the potential to develop versions of the lens that are suited to comparative analysis of capabilities at a local area level to support enabling action by community and local actors. There was also interest in how the conceptual tool could be tested to enable validation of the conceptual tool through empirical application to real life offers.

The internal workshops with SSEN and WPD enabled staff to try out using the lens as a framework for thinking about the role of network operators in enabling uptake of new energy offers in their areas of operation, including their relevance to ongoing innovation trials.

## 2.6 Next steps – validation, market monitoring, ‘tool’ design and release

Intended next steps for the *Smart and Fair?* programme are to undertake research that gathers empirical evidence from real world smart energy type offers to test the validity of the lens and the tools developed. Potential routes to verifying the lens and associated tools include:

- Systematic review of empirical evidence to understand the factors influencing uptake of offers, including how individual capability factors relate to each other (as correlation or causal).
- Direct testing of how correctly the tools predict uptake of specific types of offers (or of individual offers) and how this relates to socio-demographic characteristics associated with capabilities.
- Targeted research to explore the role of personal, social and behavioural factors in shaping uptake of offers, either through collection and analysis of real world data or through the design and construct of experimental trials. The use of trials has its limitations due to the likely systematic bias introduced at the points of recruitment and trial-design factors, such as rewards for participation.

Concern to understand the fairness of the smart energy transition must direct the design of research. In particular, there is a need to gain a better understanding of the nature and importance of personal and social factors and how these interact with other, more easily observable and objectively measurable capability factors, such as dwelling type.

Market monitoring activities will be important to understand what actual offers are coming to market, who they are being aimed at and how (including communication channels and different ‘tiers’ or variant offers), what are the ‘essential’ and ‘nice to have’ requirements for participation in specific offers and the associated pricing and financing options.

The *Smart and Fair?* Offer Profiling Tool has been designed to enable smart energy offers to be assessed against the Capability Lens, using existing measures of capability factors at household level for the population of Great Britain. The Capability Lens has also informed the data assembled and curated as part of the Consumer Classification Model. These are introduced, respectively, in Sections 3 and 4 below.

---

5 The example offers used were: Local peer-to-peer trading from local PV installations; Energy storage as a service (leased battery); Vehicle to Grid EV leasing; Domestic PV/battery ‘island’; Hybrid heat pump; Heat as service (‘Warm hours’); EV smart charger with ToU tariff; Dynamic ToU tariff.



### 3 *Smart and Fair?* Offer Profiling Tool

The Offer Profiling Tool provides a framework to assess systematically the capabilities and characteristics required for households to participate in one or multiple smart energy offers. The tool is currently an Excel spreadsheet based on the Capability Lens and at this stage should be considered a beta version.

The Offer Profiling Tool enables the tool user to apply the insights of the Capability Lens to a smart energy offer. It facilitates consideration of how consumer capabilities and characteristics are relevant to the likely suitability of an offer for take up by different consumer households.

Experience of using the tool suggests this exercise not only reveals the characteristics of those households more likely to take up an offer, it also encourages users to be more precise in their conception of the offer being considered. This is because the tool effectively ‘asks the question’ of whether any of a wide range of capabilities might be relevant to participation.

By using the Offer Profiling Tool to assess a number of different offers, it can help build up a picture of the required capabilities which are common to many offers and which ones tend to occur in combination both within offers and for individual consumers.

As explained in Section 4, using the outputs of the Offer Profiling Tool, the Consumer Classification Model can then quantify and locate these potential participants and also reveal those most ‘left behind’ by virtue of the offer being unsuited to their combination of capabilities.

An assessment of either individual offers or multiple offers can suggest potential opportunities for mitigation – interventions which would allow more people to participate in an offer. At a very simple level, if high speed broadband is an essential attribute to take up an offer, providing high speed broadband would be an effective mitigation for those households for which that is the only ‘missing’ attribute. Similarly, if tenants in private rented dwellings appear to be excluded by virtue of not being able to make decisions about their home, regulations to require landlords to allow tenants to take up such offers might mitigate that limitation (though obviously not any others). In Section 4 we describe how the Consumer Classification Model can be used to reveal the likely impact of such mitigating interventions.

User testing of the Offer Profiling Tool also revealed its value as a stimulus to discussion between people who have each assessed an offer. That is because the assessments inevitably have a fair degree of subjectivity; they cannot be precise. But by ensuring users consider offers in terms of the demands they place on participating consumers, the Offer Profiling Tool in a number of different hands will typically generate a range of perspectives regarding the same offer. Exploring the differences between these perspectives can help colleagues to deepen their understanding of both the offer(s) in question and the consumers likely to participate.

### 3.1 The principal features of the Offer Profiling Tool

The Offer Profiling Tool uses the Capability Lens as its backbone. As explained in Section 2 above, the Capability Lens identifies a wide range of consumer capabilities and characteristics relevant to understanding a household's ability to engage with the energy market. In the Offer Profiling Tool, these capabilities and characteristics are presented as 'attributes' of the consumer (and their household and dwelling). Each capability 'attribute' in the Offer Profiling Tool can be ranked on its relevance to the offer, from 'not important' to 'essential'. The importance provides a weighting that helps to reveal essential, important, or desirable consumer capability attributes. Some attributes may be considered not relevant to consumer uptake of a particular offer.

Conditions were added as a dropdown box for each attribute. In this context, 'Conditions' are the criteria required to meet the needs of the offer. Where the attribute is measured by discrete or continuous variables, the conditions can be scales (e.g. 'high', 'medium', 'low' or 'above x', 'below y'), for example with the household disposable income attribute. Conditions can also be descriptive, such as for the attribute 'Tenure type' (a categorical value), and it may be that more than one offer is suitable for one tenure type so the conditions in that dropdown menu are:

- Private rented.
- Owner occupier.
- Social rented.
- Private and social rented.
- Owner occupier and private rented.
- Owner occupier and social rented.

These conditions are replicated in the Consumer Classification Model (see Section 4).

The free text notes column allows the user to add more detail about the capabilities required or their rationale for their ranking.

The tool generates a chart (shown in Figure 3) which identifies the consumer capabilities (attributes) required by an offer, including as a list of essential, important and desirable attributes. This enables comparisons between offers to be made easily. The chart output enables a snapshot view of which cluster of capabilities dominates in terms of influencing a consumer's ability to participate in that offer. This can bring attention to where attention should be focused on measures to enable broader uptake of an offer.

Macros are used throughout the tool to provide a clear process to follow and enable automated generation of outputs which can be saved and compared with those for other offers.

The tool was tested by researchers at CSE as well as a small number of external stakeholders familiar with the smart energy market. The testing aimed to improve the accessibility and intuitiveness of the tool so that users do not require specific training.

**Figure 3: Offer Profiling Tool results tab 'attributes required for offer' chart**

The tool instructions were updated following the testing and the language around capabilities was changed to attributes as users thought this better reflected the options they were choosing from. Users also thought it would be useful to quantify the number of households that could take part in each offer. This is currently being developed as part of the Consumer Classification Model.

### 3.2 What can the Offer Profiling Tool be used for?

The tool has a variety of uses and purposes, including as part of an impact assessment of smart energy offers on vulnerable consumers. A user can compare multiple smart energy offers by their differing attributes to build a picture of which households are more or less able to take part in each offer. When using the tool on multiple offers, it is possible to determine which attributes are required by many offers; this therefore also suggests that households without these attributes are the households most at risk of being 'left behind'.

The tool visualises the quantity and cluster of attributes required to take part in an offer to aid comparison between offers. However, users should beware of treating the number of attributes required as a proxy for the accessibility of different offers: some attributes are harder to change than others.

The tool can aid discussion around areas where mitigation can be applied to broaden the range of households that can take part in an offer. This may involve changing the offer so that a particular attribute is no longer essential or by assuming an intervention is made to ensure more households have an essential attribute (see Section 4 for how we can assess the impact of different types of mitigation). The tool can be used to assess offers before and after mitigation measures have been introduced to show the potential differences in attributes and the distribution across essential, important and desirable. The findings from such an assessment can be used to inform choices about the innovative solution itself. They can also be used to influence industry-wide and government policy discussion on investment, fiscal or other policy measures to unlock fairer participation in the smart energy transition.

### 3.3 Who is the Offer Profiling Tool for?

The tool can be used by anyone with an interest in who can take part in smart energy offers. This includes companies engaged in developing or promoting offers, including suppliers and distribution network operators (DNOs). It also includes policy makers and the regulator as a tool to employ in considering the effects of smart energy offers on vulnerable consumers. Advice providers such as CSE or Citizens Advice may find the tool useful when considering what offers are appropriate to their client groups.

### 3.4 Outcomes of the Offer Profiling Tool

The tool will encourage users to apply the Capability Lens when making decisions about offer design, targeting or decision-making. The process of filling out attributes and conditions is a thought-provoking experience as certain capabilities may be overlooked if they are not directly considered. It can also aid discussions around the potential value of different types of mitigation measures.

The tool produces results that feed into the Consumer Classification Model. In turn, this can also identify groups who are unable to access the offers. Analysis can be undertaken to understand how many more households would be able to take up an offer if a certain capability was less necessary (because the offer had been re-designed) or its absence had been mitigated (by enabling more people to have that capability). See Section 4 on the Consumer Classification Model for further information.



## 4 *Smart and Fair?* Consumer Classification Model

The development of the Consumer Classification Model represents the third stage of the *Smart and Fair?* project. The structure, learning and outputs from both the Capability Lens and the Offer Profiling Tool have directly fed into its design. The key focus in the development of the model has been to match the capabilities and offer requirements identified by the Capability Lens and Offer Profiling Tool with spatial data that represents all households (or all consumers at a household level) in England.

As is typical with any model, the Consumer Classification Model is likely to go through several more iterations with the use of additional data and with new functions added to enable it to become more sophisticated at identifying certain types of consumers, their capabilities and the smart energy offers they are likely to access.

Notwithstanding this future potential, a significant amount of data processing and analysis has been conducted for this first iteration and this section details that work. The results presented in the latter half of this section should be considered more as a demonstration of the strengths of the model and the insights it can provide (as well as its limitations), rather than a comprehensive analysis of the emerging smart energy market.

As noted below in Section 5.6, there is still much work to be done to validate:

- a. The assessments undertaken with the Offer Profiling Tool – do they actually capture the characteristics of people taking up the offer and their ability to benefit from it?
- b. The relationships between the available household-level data chosen to represent the attributes in the Capability Lens and actual household data (particularly for, for example, energy use profile and demand flexibility attributes).
- c. Whether different types of households take up offers as predicted by the Offer Profiling Tool and Consumer Classification Model.

### 4.1 Summary of the model

The Consumer Classification Model is an analytical model developed by CSE that enables different smart energy offers to be modelled and specific consumer types to be identified at household level in relation to their likely engagement with these offers. The model has been designed alongside the Offer Profiling Tool and, wherever the data allows, has used the outputs from the Offer Profiling Tool analysis to identify consumers that match the essential, important and desirable characteristics listed for different offers.

In addition to modelling specific offers, the model can also simulate the removal of potential market barriers and consider mitigation issues that could allow a wider set of consumers to engage with offers (on the assumption that some households will be willing but not able to access an offer). This approach allows users to consider which

key characteristics or capabilities may be overcome with a mitigation programme. It also identifies a second set of households who, while currently unable to access a specific offer, could do so if one of the capabilities, criteria or characteristics that prevent them from doing so are addressed. The assumption behind the model is that if one of the barriers preventing households from participating in an offer is overcome by mitigation then these households will then be both willing and able to engage with a particular type of offer.

The model can also assess multiple offers in combination, including mitigation options. Running the model on a number of different offers, it is then possible to profile the types of households who are most consistently able to access a range of different offers. In addition, that analysis can also reveal which consumers lack the capabilities or circumstances to engage with any of these new emerging energy system offers. Further analysis can then be conducted to reveal further information and common characteristics of these 'left behind' consumers.

In summary, the model offers various analytical options. For individual offers, the Consumer Classification Model is able to:

- Identify and map the households and dwellings who are most likely to have the capabilities required to take up, engage with or access a particular offer (based on the outputs of the Offer Profiling Tool).
- Understand the impact of mitigation options in terms of enabling additional households or consumers who miss out from being in the 'most likely to engage' group of households, but only through one limiting factor.
- Produce summary statistics for any or all groups of households based on the extent of their engagement in a smart energy offer (i.e. the numbers of people likely to access an offer, and disaggregated by other characteristics such as tenure, fuel poverty, age band).

When combining offers in a multi-offer analysis, the model can also undertake the following analysis:

- Reveal which types of households or consumers are most likely to be able to participate in a smart energy system in the future based on their abilities to routinely engage with or access multiple offers analysed in the model.
- Alternatively, identify those households who are unable to access any offers assessed using the tool, and therefore reveal the group of households who are most likely to be 'left behind' by the transition to a smart energy system.

Outputs from the model are based on spatial data sources and so results from either single offers or multiple offer analysis can also be mapped. This can either be at address level or by higher levels of geographies, such as Census Output Areas or Electoral Wards by aggregating address level results.

## 4.2 Data underpinning the model

At the core of this model is a dataset that has been compiled from a range of different data sources, from address level data upwards to data available at higher levels of geography. These are discussed in more detail below. The initial phase of building the datasets took the Capability Lens as a starting point and reviewed all potential sources of data available that could be linked to the characteristics and capabilities listed in the lens. The overarching aim was to identify data at address level wherever possible and then build up the data to higher levels of geography (e.g. postcode, census output area) wherever data wasn't available at address level.

The spine of the datasets used Experian Mosaic household classification data.

Mosaic is a geodemographic classification of households that is based on household and individual data collated from a number of government and commercial sources. Mosaic allocates every household (i.e. at address level) in to one of 15 'groups' and 66 detailed 'types'. Licencing Mosaic data also grants access to various online Experian tools which allow users to explore which household types best fit with certain socio-demographic indicators. In total there are approximately 250 different topics that can be explored to profile different Mosaic categories. These cover indicators such as values and attitudes (including toward environmental issues and technology), educational attainment, employment status, income levels, ethnicity, main forms of communication, internet usage, access to services, car ownership, regularity of visiting GPs and so on. Using Mosaics profiling tool allows exploration of these variables and identification of specific types which best match a particular profile. These identified households can then be mapped at address level or other levels of geography.

In addition to the Mosaic data, a number of other Experian household variables were used in the tool. These included the following fields:

- Household composition (e.g. family type)
- Number of adults in household
- Residence/property type
- Fuel poverty flag
- Presence of children (age bands 0-4, 5-11, 12-17)
- Age of head of household
- Number of bedrooms
- Tenure
- Property age
- Mains gas connection

Further property information at address level was added using EPC data, including information on the overall energy efficiency of the dwelling, heating system and fuel. It should be noted that not all domestic properties have an EPC record and the coverage across England is approximately 60% with variations by rurality; proportionally more urban dwellings have had EPC assessments than rural dwellings.

Further data was appended to the datasets by postcode. This included information on broadband speeds (including types of connection, and typical download and upload speeds), and average estimated electricity and mains gas consumption (kWh). The electricity consumption statistics published by the Department for Business Energy and Industrial Strategy (BEIS) splits data by standard electricity meters and by

economy 7 meters, allowing energy consumption data to be separated by those using electricity as a heating fuel.

Table 2 presents the list of characteristics and capabilities from the Capability Lens alongside a checklist of data sources, indicating where direct data can be matched to fields, where proxies have been used, and where no data is currently available. A discussion of potential data sources was held as part of a stakeholder workshop in the early stages of model development, during which participants provided suggestions and ideas for additional datasets to use to match against the Capability Lens characteristics. These inputs helped to finalise the list of data sources shown in Table 2.

For several of the characteristics there are other known data sources that haven't been brought into this first version of the model due to time and technical constraints. However, further opportunities will be explored to feature these in future versions of the model. Some of these are also indicated in the table below.

### Data caveats

---

Despite using a diverse range of datasets, there are a number of key capabilities and attributes included in the Capability Lens that it is currently difficult to match to data or derive from data fields, and that cannot currently be included in the Consumer Classification Model. These are shown in Table 2. Matching data to some of the 'Energy tech & usage' cluster factors has proven to be difficult, including finding information on existing solar PV installations, existing battery storage, smart appliances, high energy use appliances, and other existing energy equipment at address level or postcode level. It is also hard to locate information on where smart meters have been installed using small area statistics or by socio-demographic profile.

In addition, Mosaic data has been used to allocate certain attributes, particularly those in the 'Personal & social' cluster. The current methodology allocates the same value (e.g. attitude to technology or environmental values) to all households in a Mosaic type. Mosaic types represent between 40,000 and 600,000 households and within these groups there is likely to be variation in characteristics, behaviours and values. However, for the purposes of this modelling, each household in a Mosaic type has been treated as having the same value.

Therefore, it is important to note that there are some limitations to the modelling in terms of identifying certain consumer types at address level. There are also gaps in the England-wide datasets used in the Consumer Classification Model when compared to the Capability Lens and a direct identification of all the capabilities required is not possible with the current version of the model. While it is unlikely that all capabilities, attitudes and values will be able to be included in the model, future work will look to fill some of these data gaps by identifying additional datasets that may be added to the tool in forthcoming versions.

It should also be noted, of course, that any errors and uncertainties inherent in the above datasets will be reproduced in the Consumer Classification Model.

Table 2: List of data sources used in the Consumer Classification Model linked to the Capability Lens clusters and factors.

| Cluster               | Factor   | Experian Mosaic (address level) | Experian household (address level) | EPC data (address level) | Ofcom (Postcode level) | BEIS (Postcode level) | Comments   |
|-----------------------|--|---------------------------------|------------------------------------|--------------------------|------------------------|-----------------------|--|
| Energy tech & usage   | High electricity usage                                   |                                 |                                    |                          |                        | ✓                     | Sub-national energy consumption statistics   |
|                       | Predictable, controllable, moveable peak electricity use | Proxy                           | Proxy                              |                          |                        |                       | Proxies from both Mosaic and Experian household data   |
|                       | Existing solar PV  |                                 |                                    | ✓                        |                        |                       |  |
|                       | Existing battery storage                                 |                                 |                                    |                          |                        |                       | No data  |
|                       | Existing electric vehicle                                | ✓                               |                                    |                          |                        |                       |  |
|                       | Other existing energy equipment                          |                                 |                                    |                          |                        |                       | No data  |
|                       | Heating type   |                                 |                                    | ✓                        |                        |                       |  |
|                       | Smart appliances   |                                 |                                    |                          |                        |                       | No data  |
|                       | High energy use appliances                               |                                 |                                    |                          |                        |                       | No data  |
| Dwelling & local area | Property energy efficiency                               |                                 |                                    | ✓                        |                        |                       |  |
|                       | On mains gas   |                                 | ✓                                  |                          |                        |                       | Also, off gas postcode data from Xoserve   |
|                       | Suitability for solar PV                                 |                                 |                                    | #                        |                        |                       | In future versions of the Consumer Classification Model it may be possible to model this using LIDAR data but that has not been included in this version.              |
|                       | Off-street parking or outdoor space                      |                                 | Proxy                              |                          |                        |                       | Proxies from Experian household data   |
|                       | Indoor space to install new tech                         |                                 | Proxy                              |                          |                        |                       | Proxies from Experian household data   |
|                       | Network constraints                                      |                                 |                                    |                          |                        |                       | It may be possible to obtain this data from DNOs when using the Consumer Classification Model in a small area or region, but it has not been included in this version. |
|                       | Smart meter  |                                 |                                    |                          |                        |                       | No known data available  |

Table 2 cont

| Cluster                       | Factor   | Experian Mosaic (address level) | Experian household (address level) | EPC data (address level) | Ofcom (Postcode level) | BEIS (Postcode level) | Comments   |
|-------------------------------|--|---------------------------------|------------------------------------|--------------------------|------------------------|-----------------------|--|
| Financial                     | Household disposable income                    | Proxy                           |                                    |                          |                        |                       |  |
|                               | Income reliability                             | Proxy                           |                                    |                          |                        |                       |  |
|                               | Savings  |                                 |                                    |                          |                        |                       | No data  |
|                               | Credit score                                   |                                 |                                    |                          |                        |                       | No data  |
|                               | Willingness to invest or borrow                | Proxy                           |                                    |                          |                        |                       |  |
|                               | Tenure type                                    |                                 | ✓                                  |                          |                        |                       |  |
|                               | Tenure length and security                     | ✓                               |                                    |                          |                        |                       |  |
| Mortgage and lease conditions | Proxy  |                                 |                                    |                          |                        |                       |  |
| Digital tech readiness        | Smartphone                                     | ✓                               |                                    |                          |                        |                       |  |
|                               | Digital capability                             | Proxy                           |                                    |                          |                        |                       | Data also available on 'Internet user type' at LSOA level (CDRC) |
|                               | Mobile internet coverage                       |                                 |                                    |                          |                        |                       | No data  |
|                               | Home broadband speed                           |                                 |                                    |                          | ✓                      |                       | Ofcom Connected Nations - postcode level                         |
|                               | Open to new technology                         | ✓                               |                                    |                          |                        |                       |  |
| Personal & social             | Resilience to power outage                     |                                 |                                    |                          |                        |                       | No data  |
|                               | Good health and free from disabling conditions | ✓                               |                                    |                          |                        |                       |  |
|                               | Flexibility of lifestyle                       | Proxy                           | Proxy                              |                          |                        |                       | Proxies from both Mosaic and Experian household data             |
|                               | Cutting edge                                   | ✓                               |                                    |                          |                        |                       |  |
|                               | Trusting                                       |                                 |                                    |                          |                        |                       | No data  |
|                               | Motivated by eco values                        | ✓                               |                                    |                          |                        |                       |  |
|                               | Positive attitude to risk                      | ✓                               |                                    |                          |                        |                       |  |
|                               | Willingness to change                          | ✓                               |                                    |                          |                        |                       |  |
| Social capital                |  |                                 |                                    |                          |                        | No data               |  |

### 4.3 Modelling smart energy offers in the Consumer Classification Model

The model is based upon a dataset built by combining the sources of data listed above. On top of this dataset a series of functions have been developed that run on certain fields in the data and allow users to define certain consumer capabilities and household and dwelling characteristics which align with the requirements of likely uptake behaviour of certain 'smart energy offers'. In essence, the functions allow users to identify which households are likely to take up a certain offer or not. A full description of each offer considered for this stage of the data analysis is described in more detail further below.

An overall approach when designing these functions has been to consider an adoption curve within the population which segments different household types which have different attitudes to new markets and represent groups of households who are likely to adopt new technologies over different time frames (e.g. early adopters). Thus the group of people taking up offers can be further split into different adopter groups of each offer. This approach is described in the following section.

#### 4.3.1 Use of an adoption curve to anticipate uptake of offers

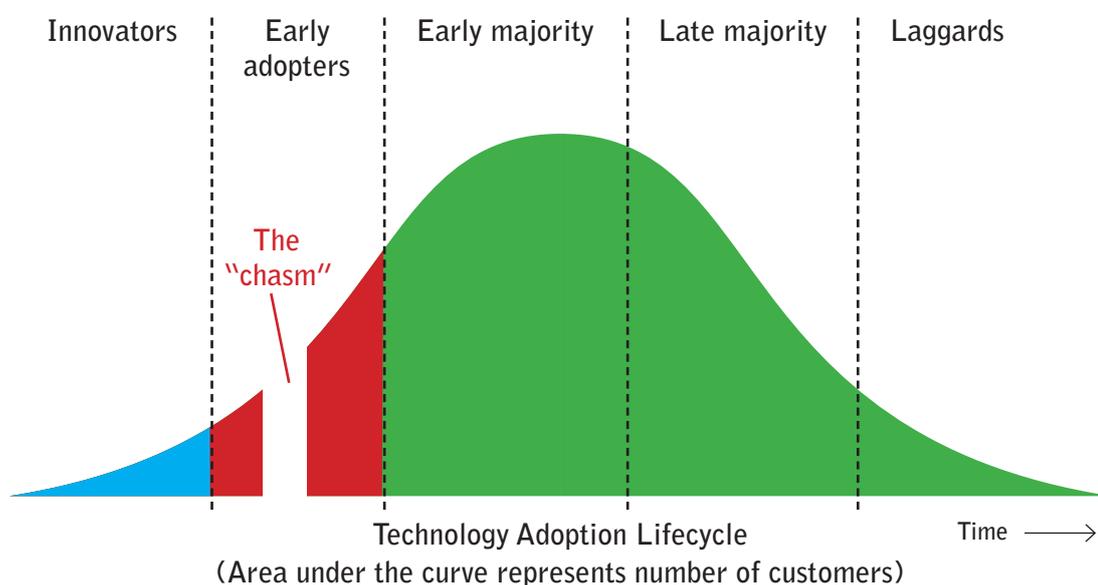
---

Once the model has been run with a smart energy offer, the groups of the population can be split into two groups, those able to take part in an offer and those not able to take part. These groups can then be further split based on their 'position' on the technology adoption curve (which is also sometimes referred to as a 'technology diffusion curve' or 'technology adoption life cycle'). This model was first introduced by Everett Rogers as part of his 1962 book *Diffusion of Innovations*. It has since been applied in numerous contexts including agricultural practices, health promotion and conservation biology. The model separates the groups into the following adopter categories:

- Innovators
- Early adopters
- Early majority
- Late majority
- Laggards

The factors that affect where someone is placed on the adoption curve are based on psychological and demographic characteristics such as:

- Mind-set (whether people focus on thinking in terms of the past, present or future).
- Risk and uncertainty (i.e. embracing risk versus risk aversion).
- Comfort level with the status quo.
- Education and understanding of technology.
- Income level.
- Socialisation networks.

**Figure 4: Technology adoption lifecycle<sup>5</sup>**

A successful innovation relies on the innovators and early adopters who are able to take part starting the uptake of the offer. The move from the early adopters into the early majority has been described as ‘crossing the chasm’. This can be the most difficult step and if successful the adoption will cascade thereby triggering the adoption by the mass-market and the offer becomes a standard (Rayna and Striukova, 2009).

Based on background information regarding attitude to technologies and other characteristics that could be matched to the psychological and demographic characteristics listed above, each Mosaic household type was allocated to one of the groups on the adoption curve for each Mosaic classification type, with ‘innovators’ and ‘early adopters’ combined as one group.

The inclusion of the technology adoption curve within the Consumer Classification Model also allowed some consideration of timescales of adoption. For instance, there will be some households who are perfectly able to take up a smart energy offer but will not at first purely because it is novel. An aspect of the modelling has been used to identify early adopters (those groups who are both able and willing to take up an offer) who are the most likely set of households to initiate adoption of a technology and be key in increasing adoption in the wider population.

Introducing this adoption curve framework ensures we can consider the potential growth of participation over time (see Section 4.4.2 for discussion of how we consider ‘over time’ in this context). This enables us to explore in a more sophisticated fashion where we are simply revealing the social norming and perceived de-risking process

<sup>6</sup> Kumbar, 2017, <https://medium.com/@shivayogiks/what-is-technology-adoption-life-cycle-and-chasm-e07084e7991f>

that comes with the early stages of innovation and system change and when we are revealing more persistent exclusion of certain types of consumer over time from participating in a smarter energy system. This should help to ensure that we can embrace the need for the innovation to drive the required increase in ‘smartness’ not to be immediately inhibited by imposing early the need to achieve ‘fairness’ in every offer. This is not to deny the potential in some cases to design in inclusivity. These issues are explored more fully in Section 5.2 below.

#### 4.3.2 Specific offers profiled in the Consumer Classification Model

---

As part of the analysis to demonstrate how the Consumer Classification Model can be used, six current or emerging smart energy market offers were profiled using the Offer Profiling Tool and the energy consumer datasets. Each of these offers and a paragraph summarising their requirements and the most likely consumers to engage with these offers are described below.<sup>7</sup>

##### *Dynamic time of use tariff*

This offer involves the householder signing up to a dynamic time of use (ToU) tariff, such as Octopus Energy’s Agile Octopus tariff. Typically, the ToU tariff is updated daily and accessible via a smart phone app. Prices vary each day and broadly reflect wholesale electricity and gas prices. There is a cap to prevent households from price surges.

This offer requires few specific dwelling characteristics other than having a smart meter and a decent and reliable broadband connection and mobile phone signal. Interacting with this offer is more about consumer attitudes and values. Households will need a smart phone and a degree of digital literacy to feel confident they can understand how to interact with the variable tariff rates. Dynamic time of use tariffs are also most likely to appeal to households who like trying out new things and changing habits, particularly with regard to early market emergence. They will also need to have some flexibility with their energy use and have good level of trust in energy suppliers offering such new types of tariffs.

##### *Energy storage as a service*

Under this offer, householders are paid to host a battery that is installed and managed by an aggregator. The battery will automatically be charged at times of low demand or high supply and the electricity consumption in homes will automatically switch to use the battery at peak times.

Homes will need sufficient space to store a battery and will need a smart meter installed. Those on short term tenancy agreements and in social housing are less likely

---

<sup>7</sup> Please note that, while it is possible – indeed likely – that we have misrepresented the offers or profiled their requirements of consumers inaccurately, the point at this stage in the research programme is to demonstrate the potential revelatory power of the Offer Profiling Tool and Consumer Classification Model. The same is true for the extent to which each offer is commercially viable and likely to emerge; our purpose here is to demonstrate what these tools can do rather than our understanding of the emerging market in smart energy offers.

to be able to adapt their homes for this offer, so it is most likely to favour home owners in larger homes. Battery storage is a relatively new concept and this is likely to require consumers to be open to new technology, a willingness to change the way energy in the home is used, and trust in energy suppliers. It is also most likely to benefit those with higher and 'peaky' electricity use, yet who are unable to be flexible with when they consume electricity.

#### *Electric vehicle smart charging with time of use tariff*

This offer is specifically for electric vehicle owners and includes a tariff bundle including a smart EV charger with a mobile phone app to allow users to set specified charging schedules. The app can also automatically charge EVs when the grid is generating low carbon electricity or the tariff is at a lower price.

This offer obviously requires EV ownership and appears most applicable for households with off street parking and a private charging point or the ability to have one installed on their property – thus favouring home owners. The requirement of EV ownership (or leasing) indicates that this is only likely to be accessible for those able to afford the upfront costs of an electric vehicle or have a high regularly income to pay month leasing or loan costs on a new car. The offer also requires a smart meter to communicate with the grid and a smart phone and reliable home broadband. It is best suited to those with a predictable yet moveable energy use profile and is going to appeal to those with eco values who want to charge their vehicles using low carbon electricity wherever possible.

#### *Hybrid heating (as a service)*

This offer involves a ground or air source heat pump added to an existing gas central heating system with smart controls, with the system installed by a third party aggregator. Heat is sold to the householder as 'warm hours', with the householder typically signing up to a 3 year contract. The smart controls are set to meet the desired temperatures in the cheapest way, using electricity as standard but gas when the price of electricity is higher.

The nature of this offer means that households will need to have an existing mains gas system and be on the gas grid. They will also need sufficient outside space to install a ground or air source heat pump and permission to do so (i.e. unlikely for private rented households and social housing tenants would need to be part of a landlord-led initiative), an efficient home (e.g. EPC band D or above), a smart meter, a decent credit rating and be driven by eco values. They will need to trust the aggregator providing the service and that the switching between gas and electricity in the control of the hybrid set up is being done at the optimum time to maintain low fuel costs and carbon emissions while meeting household needs for warmth.

#### *PV Storage Island*

Under this offer, householders purchase and install a PV system and an integrated battery storage unit is paid for and installed by an aggregator. The aggregator buys

the surplus electricity generated by the PV system from the householders and then controls when the battery storage unit discharges (e.g. at times of peak value). The offer could help to manage constraints on the local grid or take advantage of balancing markets, while the householders will achieve higher returns on their investment in the PV system through selling the surplus electricity generated at a higher price than the smart export guarantee.

Thus with this offer, PV suitability of the property is key as is the space to install a battery storage system. Householders will also require sufficient funds to install a PV system and there are likely to be credit checks on consumers before the aggregator agrees to the battery installation. The required changes to the dwelling are likely to favour owner occupiers rather than renters. As with other offers, consumers will also need to have a level of trust in the aggregator providing the service and be satisfied that they are receiving a fair price for the electricity they are selling from their PV generation.

#### *Vehicle to grid EV leasing*

The vehicle-to-grid (V2G) leasing bundle currently being piloted includes leasing a V2G electric vehicle, a smart charger, an app to control the charging schedule, signing up to a time of use tariff and installing a smart meter (if households do not already have one). As an incentive, these offers typically tend to offer some cashback too, associated with the value that can be secured by how the EV's battery is used. When plugged in, EVs can export electricity back to the grid at peak times and charge their batteries when grid demand is low (e.g overnight). Under one such offer, if vehicles were left plugged in all night from 6pm at least 12 times a month then consumers received some cashback (£30 per month). Typical costs (including the EV lease and charging) are around £300 per month.

This is going to be an offer that appeals to those already considering buying or leasing an electric vehicle, those with the ability to install private charging infrastructure and ideally for people who can leave their car parked on a driveway at home. This is going to require a level of trust – people need to have confidence that their car will be fully charged when they need it – and people will require a smart phone and have a degree of digital literacy and be confident using an app to control when they charge their vehicle. They will also need to have a reliable and high enough income to be able to afford the leasing costs, but a flexible enough lifestyle to be able to change their charging schedule if necessary. This is also likely to be targeted in areas where grid constraints are highest, so this might affect the regional marketing approach of companies offering this service.

#### **4.3.3 Modelling mitigation options to enable great participation**

---

An additional aspect of the Consumer Classification Model is to simulate a form of mitigation, which aims to remove an existing barrier to participation for certain households. This aspect of the model is still in the first phase of development. It is a simplified simulation of policy or regulation which supports non-participating

households to overcome an existing lack of capability. For example, this may be regulation around private tenancy agreements that allow households to install 'behind the meter' smart energy kit, or work to ensure broadband services and mobile phone signals are boosted in areas with slow or low quality reception, or the provision of grants or low cost loans to allow lower income households to cover upfront costs of certain technologies (such as smart appliances or controls, electric vehicles, PV systems or battery storage units).

For each of the offers analysed, a mitigation element was incorporated into the assessment. Table 3 below summarises the mitigation options that were explored. The groups of households who were able to access offers after these individual mitigation interventions are classified and reported on separately below. Note that in each case the only households who can then participate and those whose only 'gap' in capabilities was the one mitigated. A grant to enable a low income household to acquire an EV and smart charging kit will not deal with a lack of off-street parking.

**Table 3: Mitigation options modelled in the Consumer Classification Model**

| Smart energy offer                                      | Mitigation options modelled   | Who is 'mitigated'                           |
|---|---|--|
| Dynamic time of use tariff                              | Increased high speed broadband roll out enabling those in areas with slow or unreliable broadband speeds to access this offer with confidence.                          | Those with poor access to broadband services |
| Energy storage as a service                             | Regulation to better support private rented and social housing tenants to install a smart meter and 'behind the meter' energy kit, in this case a battery storage unit. | Private rented and social housing tenants    |
| Electric vehicle smart charging with time of use tariff | Grants or low cost loans to enable lower income households cover the upfront capital costs of buying an electric vehicle and smart charging kit.                        | Lower income households                      |
| Hybrid heating as a service                             | Grants or low cost loans to enable lower income households cover the financial contributions to the heating system upgrades.  | Lower income households                      |
| PV Storage Island                                       | Grants or low cost loans to enable lower income households cover the upfront capital costs of buying a PV system.   | Lower income households                      |
| Vehicle to grid EV leasing                              | Regulation to better support private rented and social housing tenants to install a smart meter and 'behind the meter' energy kit, in this case a battery storage unit. | Private rented and social housing tenants    |

#### 4.3.4 Assessing the benefits of future energy market participation

---

For each of the offers analysed, the model has identified the types of households who are most likely to participate in a newly emerging smart energy system and at which stage during the adoption curve. The focus of the project has been predominantly about understanding which households or consumers are most likely to be able to access these smart energy offers, as well as profiling those households that are likely to miss out and be 'left behind' during the increasing digitisation of the energy market. It has not been, at this stage, seeking to assess the financial impact of being left behind – or the advantage of participating.

That is because the specific benefits of each of the offers reviewed using the Consumer Classification Model have not been included in the analysis. This is for two related reasons. The first is that it is not always immediately clear what the actual benefit is likely to be for participating in some of the offers (other than feeling involved and contributing to a smarter future energy system). For several offers the scale of any benefit available will be heavily dependent on how different markets for 'smart energy services' develop (e.g. demand flexibility) and how the mix of generation on the system changes over time (and thus the need for and potential value of balancing and flexibility services). It is therefore too early to be usefully definitive about these benefits. Likewise, the level of benefit available is likely to vary considerably between different consumers and it is too early in the emergence of these offers to be able to quantify and characterise these variations. For example, some savvy consumers with a flexible lifestyle could experience a noticeable reduction in their energy bills from switching to a dynamic time of use tariff. Meanwhile, other households with a more rigid lifestyle may be driven to switch to these types of tariffs because they believe they represent a more sustainable choice, but their inflexibility may well lead to their bills increasing (even if some sort of price cap is in place).

The second reason is that comparing different financial and non-financial benefits across multiple offers with the uncertainties described above presents a significant challenge and one which is difficult to address with any confidence at this stage of the market's emergence.

However, a common benefit that is associated with all of the offers is an ability to participate in a new emerging energy market. Therefore, in the analysis conducted to date (and acknowledging the gross simplification involved), we have treated each offer in the same way and assessed the main benefit as being whether households can (or are likely to) participate in an offer. Participating in any one offer is treated as just as beneficial as participating in any other offer. Accordingly, we have classified households based on their modelled participation in a future smart energy market and whether they take up any offer; this classification is described in more detail below.

This said, once these uncertainties about benefits available from different offers reduce, we believe that the analytic techniques deployed here could be used to understand better the financial consequences of participating or not participating in different offers. This could form the basis of future distributional impact assessments of the transition to a smarter energy system.

### *Combined analysis of offers*

Running each smart energy offer listed above through the Consumer Classification Model indicated which households across England are likely to take up one or more of the different offers and at what stage on the adoption curve for each offer. It was then possible to look across the simulations of all of the offers to group households into different classifications, depending on where on the adoption curve they were likely to take up the offers and whether there was a 'gap' in their ability to take up any offer that could be mitigated using only the interventions detailed in Section 4.3.3. This grouping was done using the classifications listed below. For reference to the adoption types, see the discussion of the technology adoption curve in Section 4.4.1.

In essence, the descriptions below are an attempt to show how households who are the most likely to engage with smart energy offers spread across the adoption curve (accepting that this may vary from offer to offer for a single household). It also captures how mitigation in the early stages of the smarter markets could make a difference – not by shifting a household 'up' the adoption curve in terms of their inclination to take up the innovation, but by addressing a 'gap' in capabilities that was preventing an 'early adopter' from participating who would otherwise be 'ready' attitudinally.

- ***Early adopters accessing at least one offer*** – if a household was an innovator or early adopter of at least one offer of the six modelled then they were classified in this group. They may also have been later adopters for other offers.
- ***Early majority accessing at least one offer*** - if a household was in the early majority for at least one offer of the six modelled, but was not an early adopter for any others, then they were classified in this group. (They may have also been 'late majority' adopters or 'laggards' for other offers).
- ***Early mitigation (only accessing offers after mitigation)*** – this was a set of households that were only able to take up an offer as an early adopter or early majority household following some mitigation (see above). None of these households were found to be early adopters or early majority for any offers without mitigation actions (if they had been, they would be on one of the two groups above). However, they may have been late majority or laggards for other offers.
- ***Late majority accessing at least one offer*** – this group is of households who took up at least one offer as late majority consumers and typically form most of the latter half of adopters. Under the classification used in the model, these households did not take up any offer as an early adopter or early majority and so were only likely to be participating after a few years (see Section 4.4.2 below for an example of adoption over time).
- ***Late majority mitigation (only accessing offers after mitigation)*** - this was a set of households that were only able to take up an offer as a later majority adopter household but with some mitigating measures in place (see above). None of these households were found to be early adopters, early majority or late majority for any

offers without mitigation actions. However, they may have been laggards for other offers.

- **Laggards (last of eligible/capable to take up offer)** – this group represented a set of households who are likely to be the last set of consumers to take up at least one smart energy offer after the significant majority have already engaged with the market. ‘Laggards’ is the official terms for those who are the last set of people to engage in a new technology or market produce and is used here without any derogation intended.
- **Households not taking up any offers (‘No offers’)** – None of these households had the key characteristics or required capabilities, even after mitigation, to be able to take up any smart energy offers. In the analysis, this group was further profiled by adoption curve characteristics and vulnerability.

#### 4.4 Consumer Classification Model modelling results

In this analysis, the core focus has been to explore levels of consumer participation in smart energy market offers and model their likely adoption rather than the potential distributional impacts of benefits associated with those offers. In this way, as explained in Section 4.3.4, each offer has been treated as being of equal value when compared with other offers and no explicit or specified benefit for individual offers have been considered; the benefit assumed here (of accessing an offer) is participation in a newly emerging smart energy market.

The results here present some summary findings on the numbers and types of different consumers who are likely to engage in the mix of six smart energy offers listed and described above in Section 4.3.2. The analysis has incorporated the technology adoption curve, with households identified as being most likely to take up these offers also located on the adoption curve for a specific offer as well as across all offers analysed. The results in this section include a summary description of the adopter types identified by the Consumer Classification Model.

##### 4.4.1 Adoption of smart energy market offers

---

The model was used to identify the most likely households to take up a selection of six smart energy offers, including three different mitigation approaches. The results were used to segment households in England into seven distinct groups based on whether they were able to access these offers, at what point they were likely to engage on a typical technology adoption curve and whether they could only access offers after the offer-specific mitigation intervention outlined in 4.3.3 above.

Table 4 summarises these groups, including a group of households who did not access any of the six offers.

**Table 4: Summary of smart energy offer take up**

| Smart energy consumer type  | Number of households | Proportion of households |
|---|----------------------|--------------------------|
| Early adopters accessing at least one offer                       | 1,297,000            | 5%                       |
| Early majority accessing at least one offer                       | 4,349,000            | 18%                      |
| Early mitigation (only accessing offers after mitigation)         | 679,000              | 3%                       |
| Late majority accessing at least one offer                        | 3,402,000            | 14%                      |
| Late majority mitigation (only accessing offers after mitigation) | 1,112,000            | 5%                       |
| Laggards (last of eligible/capable to take up offer)              | 1,336,000            | 6%                       |
| No offers: Total  | 11,806,000           | 49%                      |
| Group with no offers – adoption curve profile                     | Number of households | Proportion of households |
| No offers: Innovators/early adopters                              | 898,000              | 8%                       |
| No offers: Early majority   | 4,228,000            | 36%                      |
| No offers: Late majority  | 4,104,000            | 35%                      |
| No offers: Laggards   | 2,577,000            | 22%                      |

The analysis revealed that around half of English households are likely to take up at least one of the six offers, leaving another half of the population unable or unwilling to participate in the emerging smart energy market.

Of those participating, early adopters accounted for approximately 1.3 million households or 5% of England consumers. A further 4.3 million households (18%) engaged with the offer as ‘early majority’ adopters, and 3.4 million (14%) as late majority adopters. The offer-specific mitigation interventions enabled an additional 680,000 households (3%) to participate as early or early majority adopters, and 1.1 million households (5%) as late majority adopters. Laggards accounted for the remaining 1.3 million or 6% of households, and the last group to take up a smart energy offer. A summary profile of each group listed in Table 4 is presented in Section 4.4.3 below.

The results suggest that just under half of households will not adopt any of the smart energy offers included in the analysis. However, it is important to reiterate that the modelling at this stage has only reviewed six different offers and many more are likely to emerge in the near future, including more accessible versions of the offers assessed here. Therefore it should not be concluded from these results that approximately half of all households will be unable to take up smart energy offers in England. Furthermore, almost half of the group identified as being in the ‘no offers’ group are in the early adopters or early majority group; as different offers emerge more of these are likely to engage in the smart energy market.

On the other hand, about 8% of the participating households are only able to participate as a result of mitigation interventions which are not currently in preparation in the market. So these households should not be 'counted' as participating unless the mitigation interventions are brought forward and achieve the 100% success rate assumed in this analysis for illustrative purposes. That said, the mitigation interventions assessed certainly do not represent the full range of possible mitigations.

#### 4.4.2 Example of adoption/market penetration over time

---

Interpreting the timescales over which different types of households will adopt smart energy technologies, market products and smart tariffs is hard to do with any certainty and across offers of a different nature which represent both more established technologies as well as technologies in their infancy. However, in order to provide an estimate of how the adoption of these offers may play out we have made some assumptions on time periods associated with different adopters (see above for background about the 'adoption curve'), as follows:

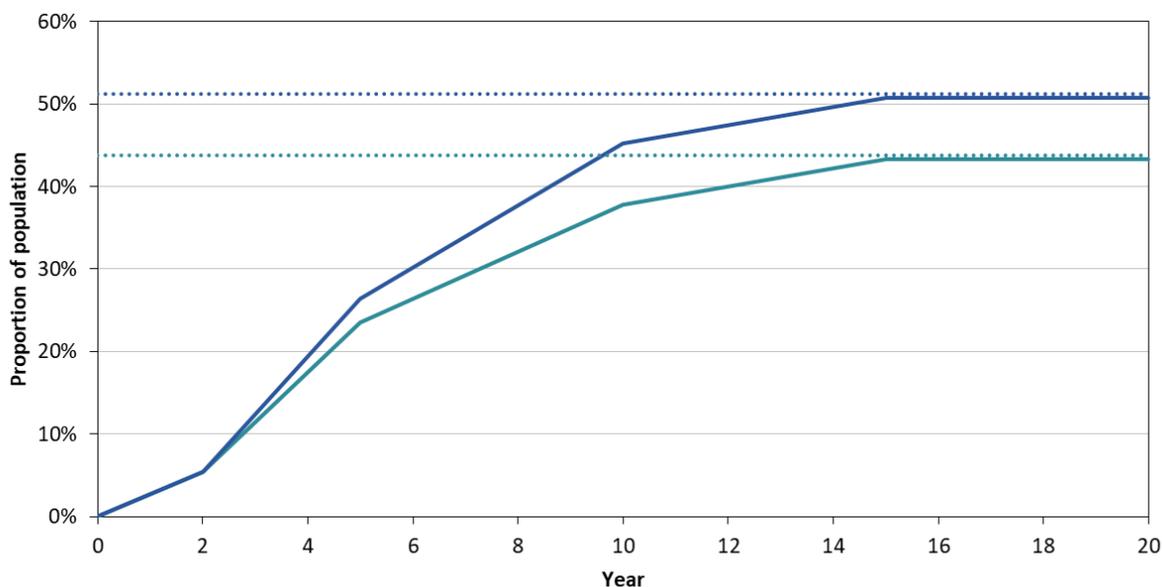
- **Innovators and Early adopters:** will adopt technologies within the first 2 years of offers emerging.
- **Early majority:** the first main group of adopters will follow suit within the next 3 to 5 years.
- **Late majority:** these households will have adopted offers within 6 to 10 years.
- **Laggards:** the last group of adopters will take up offers within 11 to 15 years of them first emerging on the market.

Based on these assumptions, the adoption of smart energy market products could be as illustrated in Figure 5. This shows an estimated roll out through a simplified s-curve, with the majority of households who are able and willing to engage having switched to using smart energy systems and technologies within 10 years.

#### 4.4.3 Profiles of different consumer types

---

The different types of households identified in the analysis and presented above in Table 4 and Table 5 are described in more detail below. The descriptions and statistics referenced in the text below have been taken from the core dataset underpinning the model and bring in additional data than the fields directly used in the model. For some of the groups there is some variation of characteristics within the group; in the descriptions below the most common or defining aspects of each group have been described. Some further statistics on each of the household consumer types are presented below in Table 6. In addition, several graphs illustrating the age profile (Figure 6), different tenures (Figure 7) and the Index of Multiple Deprivation (IMD) decile profiles (Figure 8) are shown in the figures below.

**Figure 5: Estimated time-based adoption curve of smart energy market products**

#### *Early adopters accessing at least one offer*

Early adopters accessing at least one of the six smart energy offers tended to be younger shared households or families on above average incomes. Over 80% were under 55 years, and average incomes of this group were approximately £43,000 (national average income ~£35,000). These households predominantly lived in cities with over 95% living in urban areas, compared with 80% across all households in England. A high proportion live in privately rented accommodation (36%), twice the national rate, although this partially related to the young age profile of this group, with many yet to get on the housing ladder. And most (55%) own their own homes, which are typically flats and terraced housing. Over 90% of these homes are rated in EPC band D or above.

Despite being on higher than average incomes, a third of this group report levels of financial stress which is above the national average, possibly a result of higher city rents for some households. But overall there are low levels of fuel poverty in this group and a higher number of households with degree qualification than the national average.

#### *Early majority accessing at least one offer*

Early majority households represented a group of higher income households (average household income of £49,000), typically aged between 26 and 55 years of age. This group tend to live in urban areas, typically in non-deprived areas, in terraced or semi-detached housing or converted flats that are typically older (pre-1945) and slightly less efficient than average.

Table 5: Summary statistics for different smart energy consumer household types and offers

| Type of consumer   | Total number of Households | Percentage of households in England (%) | OFFERS*                     |                          |                   |                   |                   |                            |
|--|----------------------------|---|-----------------------------|--------------------------|-------------------|-------------------|-------------------|----------------------------|
|  |                            |   | Energy storage as a service | EV smart charge with ToU | Hybrid heating    | ToU tariff        | PV storage island | Vehicle-to-grid EV leasing |
| Early adopters accessing at least one offer                  | 1,297,000                  | 5.4%                                    | 54,000                      | 268,000                  | 197,000           | 1,057,000         | 17,000            | 69,000                     |
| Early majority accessing at least one offer                  | 4,349,000                  | 18.1%                                   | 1,356,000                   | 1,189,000                | 672,000           | 3,721,000         | 1,513,000         | 545,000                    |
| Early mitigation (accessing offers after mitigation**)       | 678,000                    | 2.8%                                    | 536,000                     | 68,000                   | 144,000           | 581,000           | 21,000            | 350,000                    |
| Late majority accessing at least one offer                   | 3,402,000                  | 14.2%                                   | 1,606,000                   | 1,963,000                | 1,828,000         | 2,416,000         | 2,871,000         | 290,000                    |
| Late majority mitigation (accessing offers after mitigation) | 1,112,000                  | 4.6%                                    | 40,000                      | 381,000                  | 624,000           | 1,172,000         | 850,000           | 50,000                     |
| Laggards (last of eligible/capable to take up offer)         | 1,336,000                  | 5.6%                                    | 585,000                     | 37,000                   | 792,000           | 377,000           | 114,000           | 19,000                     |
| No offers: Total   | 11,806,000                 | 49.2%                                   | 19,804,000                  | 20,074,000               | 19,724,000        | 14,657,000        | 18,594,000        | 22,656,000                 |
| <b>Total</b>   | <b>23,980,000</b>          | <b>100.0</b>                            | <b>23,981,000</b>           | <b>23,980,000</b>        | <b>23,981,000</b> | <b>23,981,000</b> | <b>23,980,000</b> | <b>23,979,000</b>          |

\* Numbers across the offer columns do not sum to the 'Total number of households' column as some households in each 'type of consumer' took up more than one offer.

\*\* Mitigation in this modelling is the offer-specific mitigation interventions which are designed to address a key 'gap' in attributes required for that offer from the results of the Offer Profiling Tool, as outlined in Table 3. They do not represent the full range of potential mitigation which could be implemented.

They are the highest qualified of all the household groups with over 40% having a degree qualification, with below average levels of financial stress, and very low levels of fuel poverty.

*Late majority accessing at least one offer*

The households are owner occupiers on higher incomes (average household income £48,000), who tend to live more rurally. They have the lowest levels of fuel poverty of any group, live in the least deprived areas of the country, and have the low levels of financial stress. Most are over the age of 55 (75%), and around two-fifths are retired.

Typically, these households live in detached or semi-detached houses, built since 1945. However, few are rated above D and nearly a fifth are rated in EPC bands E, F or G.

*Laggards (last of eligible/capable to take up offer)*

The laggard groups is characterised by a distinctly older set of households (81% over 65 years of age), living in their own homes in more rural areas. These homes are typically bungalows, semi-detached or detached houses. These household are on lower incomes than average, with an average household income of £25,000, but are likely to have paid off their mortgages and thus have lower housing costs; they report the lowest levels of financial stress of any group. While this group has the highest rate of fuel poverty of all the groups modelled as accessing offers, at 8.6% this remains lower than the national rate. While these households are likely to access smart energy offers eventually (it is mainly their aversion to innovation which stops them participating sooner), they will be the last set of households to do so (of those that are currently able).

*Households receiving no offers*

The group of households not accessing any of the six offers analysed represent approximately half of the households in England. Thus this is a large and more diverse set of households than the groups described above. In some aspects they reflect the distribution of attributes that exist across all England, such as urban and rural location and age profile (e.g. Figure 6). Nevertheless, there are some notable contrasting characteristics between this group of households and those who were identified as the most likely to access offers.

The average income of these households is low (£26,000) and this group has high rates of fuel poverty, with 18.4% of households in fuel poverty and includes 2.1 million of the total of 2.6 million households in fuel poverty across England. They tend to live in more deprived areas, according to the index of multiple deprivation (IMD) and as shown in Figure 8 below. Most social housing tenants are in this group (3.7 million of the 4.2 million social housing tenants in England) and account for 31% of these households – twice the national proportion.

Households identified as not accessing any of the offers included in the analysis also have the highest rates of those reporting suffering financial stress (35%), those without

any formal qualifications (28%), and those with health conditions (self-reporting as being in bad or very bad health, 7.1%), and include the significant majority of households in these situations across all groups.

In Table 6 below households who did not receive any offers have been further disaggregated by their location on the adoption curve.

*Mitigation group 1: Early mitigation (only accessing offers after mitigation)*

This group is a group of younger renters, mostly aged between 18-45, living in predominantly private rented accommodation but also in social housing. They are on average incomes, with low levels of fuel poverty, but report above average levels of financial stress. This group represents households who would likely be the main beneficiaries of mitigation measures that help support rented households to make alterations to their homes in order to access smart energy offers.

Housing for this group tends to be flats or semi-detached houses, and typically newer builds (65% of homes built since 1955, 35% built since 1980). As a result, this group lives in some of the most efficient dwellings with over half being rated in EPC band C or above.

*Mitigation group 2: Late majority mitigation (only accessing offers after mitigation)*

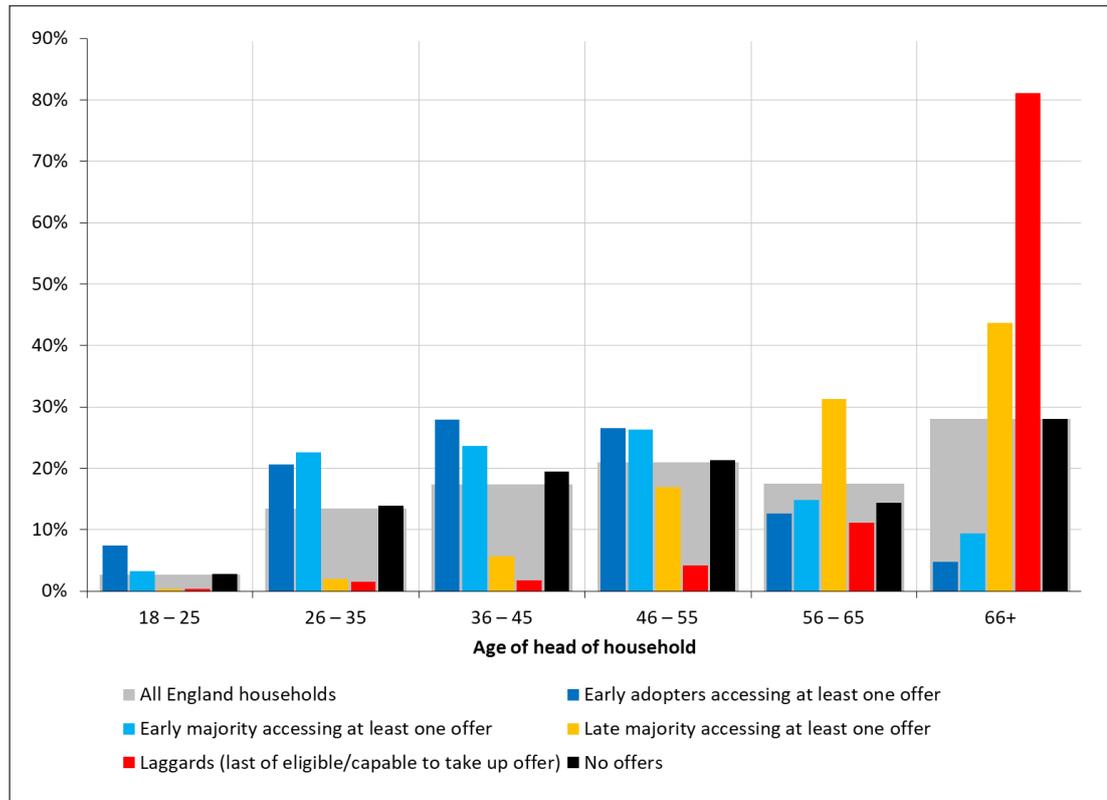
This group were identified by the modelling as being those late adopters who were only able to access the offers following some level of mitigation. These households are noteworthy for being the most rural of all the consumer types characterised in the modelling, with almost half living rurally, and many of these households will benefit from increased broadband speeds and connections (and better mobile phone coverage) that allows them to access offers which require this.

The households are on above average incomes (average £41,000) but lower than the main late majority group, and only 3.1% are in fuel poverty. Like other late majority households, this group generally represents an older set of households with 90% aged 46 years or over, and 66% over 55 years, and they tend to live in some of the least deprived areas of the country. However, as a result of living in more rural locations this group live in some of the least efficient homes across the country, with 23% rated in EPC bands E, F or G (almost twice the national proportion).

**Table 6: Characteristics of different smart energy consumer household types**

| Smart energy consumer type                                   | Number of households | Average annual household income (£) | Over 65s (%) | Households in bad or very bad health (%) | In fuel poverty (LIHC) (%) | Rural location (%) | Households with no formal qualifications (%) |
|--|----------------------|-------------------------------------|--------------|--|----------------------------|--------------------|--|
| Early adopters accessing at least one offer                  | 1,297,000            | £43,886                             | 4.8%         | 4.5%                                     | 6.5%                       | 4.4%               | 16.1%  |
| Early majority accessing at least one offer                  | 4,349,000            | £49,623                             | 9.4%         | 4.1%                                     | 2.8%                       | 7.7%               | 14.5%  |
| Early mitigation (accessing offers after mitigation)         | 678,000              | £39,936                             | 5.8%         | 4.7%                                     | 7.0%                       | 13.1%              | 17.2%  |
| Late majority accessing at least one offer                   | 3,402,000            | £48,317                             | 43.7%        | 4.2%                                     | 1.9%                       | 27.6%              | 17.8%  |
| Late majority mitigation (accessing offers after mitigation) | 1,112,000            | £41,727                             | 29.9%        | 4.3%                                     | 3.1%                       | 46.5%              | 17.6%  |
| Laggards (last of eligible/capable to take up offer)         | 1,336,000            | £24,698                             | 81.1%        | 5.4%                                     | 8.6%                       | 33.7%              | 22.7%  |
| No offers: all households                                    | <b>11,806,000</b>    | <b>£26,242</b>                      | <b>28.0%</b> | <b>7.1%</b>                              | <b>18.4%</b>               | <b>17.0%</b>       | <b>27.7%</b>                                 |
| No offers: Early adopter households                          | 898,000              | £29,161                             | 4.4%         | 6.5%                                     | 21.1%                      | 3.5%               | 24.1%  |
| No offers: Early majority households                         | 4,228,000            | £30,929                             | 3.1%         | 6.6%                                     | 9.9%                       | 18.0%              | 26.5%  |
| No offers: Late majority households                          | 4,104,000            | £26,050                             | 24.9%        | 7.8%                                     | 20.4%                      | 8.1%               | 30.0%  |
| No offers: Laggard households                                | 2,576,000            | £17,837                             | 82.2%        | 6.8%                                     | 28.3%                      | 34.4%              | 27.1%  |
| <b>All households (England)</b>                              | <b>23,980,000</b>    | <b>35,588</b>                       | <b>28.0</b>  | <b>5.7</b>                               | <b>11.0</b>                | <b>18.3</b>        | <b>22.2</b>                                  |

**Figure 6: Age profile of different smart energy consumer groups**



**Figure 7: Tenure profile of different smart energy consumer groups**

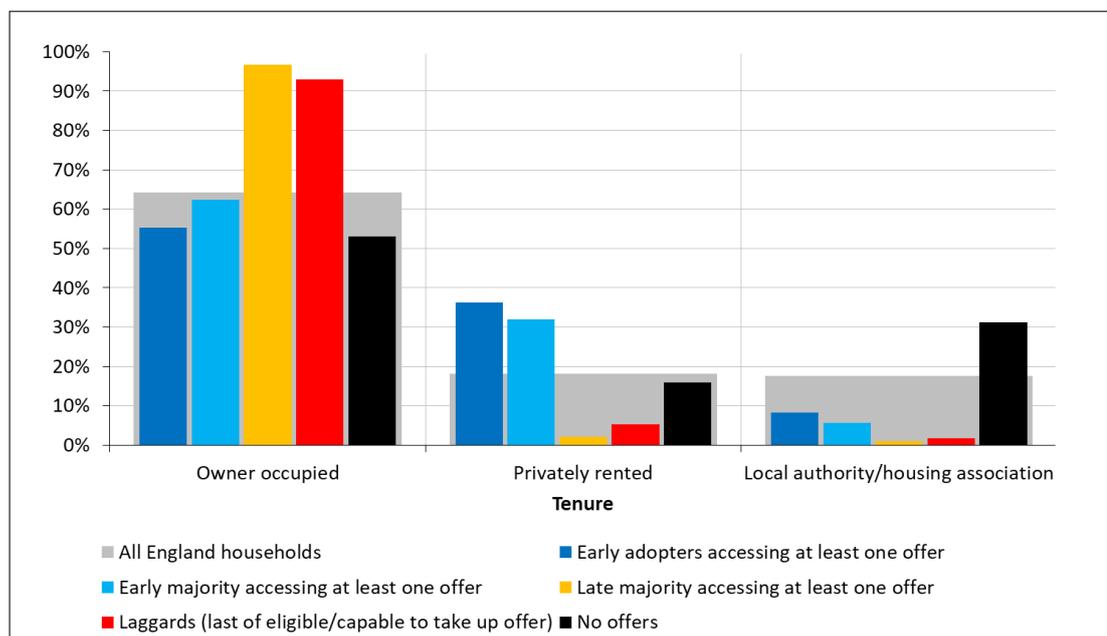


Figure 8: IMD profiles of different smart energy consumer types (option 1)

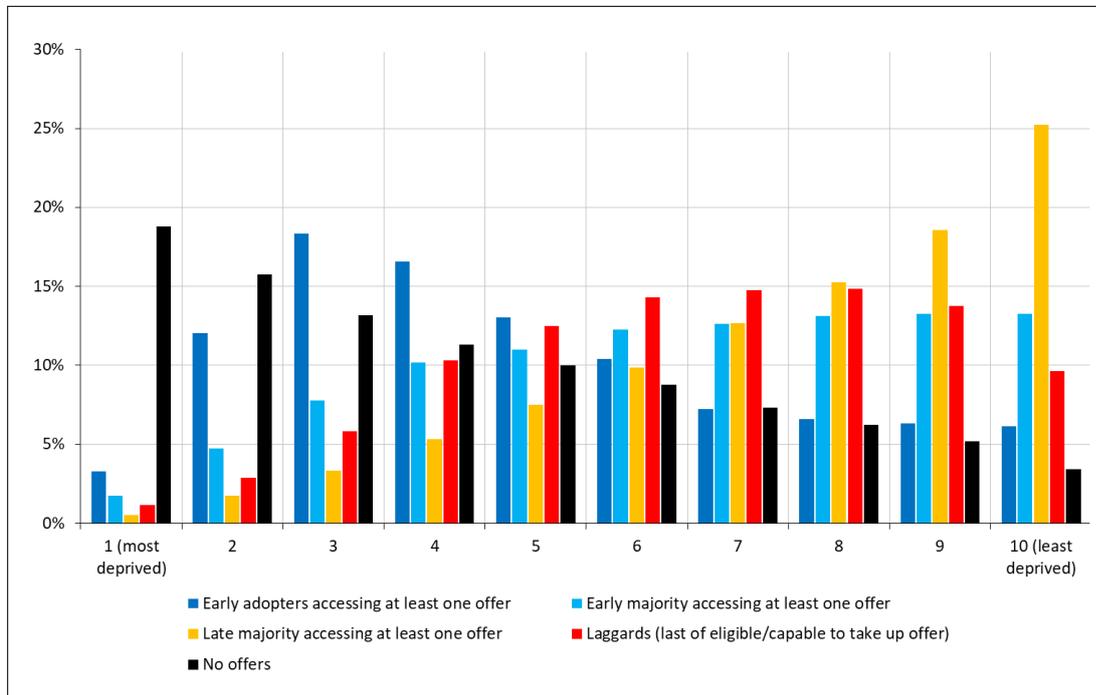
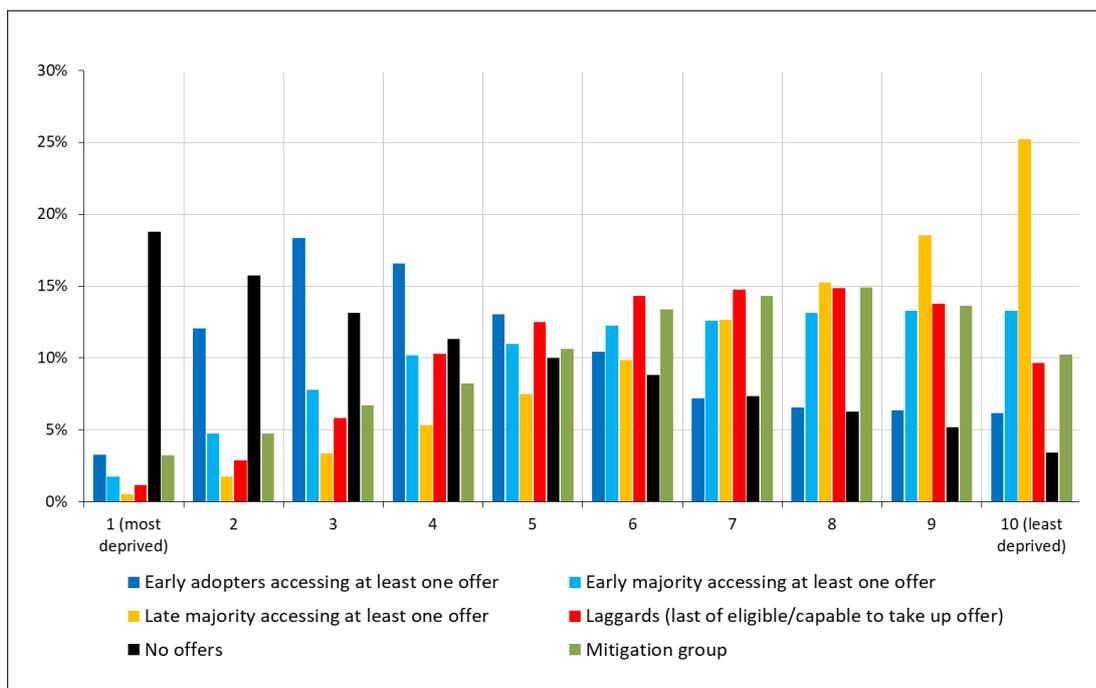


Figure 9: IMD profiles of different smart energy consumer types (option 2)



### Vulnerability within different energy consumer types

The data in the modelling datasets allows further exploration of consumer types and their characteristics. The datasets were also used to look at vulnerability across the groups. It is recognised that vulnerability can take various forms and is dependent on context. However, for the purposes of this analysis, vulnerable households have been defined as having one or more of the following characteristics:

- Being on a low income (less than 60% of median household income).
- Being in bad or very bad health.
- Being in fuel poverty.

Using this definition, vulnerability across different household types has been determined and is presented in Table 7. Those in 'No offers' are the group with the highest proportion of people in fuel poverty and with health conditions, and on average have lower incomes than most other consumer types. This is revealed in the analysis below which shows that almost half of the 'No offers' group have one or more of these vulnerabilities, representing approximately 5.5 million households. On average across England just under 3 in 10 households have one or more of these three vulnerable characteristics.

In contrast, only 6% of the late majority adopters group includes people with one or more of these vulnerable characteristics, having good incomes, low levels of fuel poverty and below average levels of health conditions. The 'Laggards' group also has

**Table 7: Estimate of numbers and proportion of vulnerable households by smart energy consumer type**

| Type of consumer   | Non-vulnerable group |       | Vulnerable group |       |
|--|----------------------|-------|------------------|-------|
|  | (number)             | (%)   | (number)         | (%)   |
| Early adopters accessing at least one offer                  | 1,044,000            | 80.5% | 253,000          | 19.5% |
| Early majority accessing at least one offer                  | 4,055,000            | 93.2% | 294,000          | 6.8%  |
| Early mitigation (accessing offers after mitigation)         | 572,000              | 84.3% | 107,000          | 15.7% |
| Late majority accessing at least one offer                   | 3,198,000            | 94.0% | 204,000          | 6.0%  |
| Late majority mitigation (accessing offers after mitigation) | 1,031,000            | 92.7% | 81,000           | 7.3%  |
| Laggards (last of eligible/capable to take up offer)         | 818,000              | 61.2% | 518,000          | 38.8% |
| No offers  | 6,272,000            | 53.1% | 5,534,000        | 46.9% |
| All England households                                       | 16,990,000           | 70.8% | 6,991,000        | 29.2% |

a high proportion of people in vulnerable circumstances. However, these households report low levels of financial stress. Poor health conditions are likely to be related to an older age profile of these households.

This analysis reveals that not only are these households likely to be missing out on smart energy offers, they are also likely to be the group with significantly higher rates of vulnerability than households who are better positioned to take advantage of smart energy offers and participate in the emerging smart energy market. Even after applying some mitigation interventions, only a small number of households from this group are enabled to participate.

For many of these more vulnerable households, the lack of participation is likely to exacerbate their existing situation and potentially increase financial inequalities as they are unable to access 'smart energy benefits' but potentially carry more of the system costs avoided by participating consumers. It is also likely to foster a 'left behind' mindset in those unable to access smart energy market offers and technologies.

#### **4.4.4 Single offer analysis: dynamic time of use tariff**

---

The analysis presented in this section so far has assessed the results of six smart energy offers and revealed the combined impact of these different types of market offers. Of course, it is possible to perform the same analysis at an individual offer level. Rather than a series of vulnerability impact analyses for each market offer, the analysis looks in more depth at the types of household who have been identified as not being able to access any offer. We hope this reveals the potential power of the combined application of the Offer Profiling Tool and Consumer Classification Model.

Table 8 presents details of the 14 million households who were identified as not having the characteristics or capabilities to switch to a dynamic time of use tariff, split by those in fuel poverty and those not in fuel poverty. It shows the main reasons why households missed out on the offer, and whether there was only one key reason ('single' factors) or multiple factors.

As part of the modelling some key characteristics required by households in order to access offers were identified through Mosaic and by identifying household types which best matched the characteristic identified by the Offer Profiling Tool. The Offer Profiling Tool outputs were used in conjunction with Mosaic data and Experian tools to select those households most likely to be interested in and able to access an offer. In the case of the dynamic time of use tariff offer, the following household characteristics were identified as being significant in whether households took up offers:

- Having good digital literacy.
- Owning a smart phone.
- Being more willing to take risks (i.e. not risk averse).
- Having a positive attitude to change.
- Having circumstances which allow for flexibility around energy use (i.e. being able shift peak demand).

**Table 8: Vulnerability in groups not accessing offers**

| Reasons missing out on offer |   | In fuel poverty* |                  | Not in fuel poverty** |                   |
|------------------------------|---|------------------|------------------|-----------------------|-------------------|
|                              |   | %                | Households       | %                     | Households        |
| <b>Single factors</b>        | Insufficient broadband speeds   | 0.4%             | 10,000           | 2.5%                  | 307,000           |
|                              | Income below threshold  | 4.9%             | 113,000          | 3.0%                  | 365,000           |
| <b>Multiple factors</b>      | Other digital literacy, attitudes and household circumstances identified using Mosaic   | 33.6%            | 775,000          | 58.2%                 | 7,184,000         |
|                              | Insufficient broadband speeds; plus, Income below threshold   | 0.8%             | 19,000           | 0.5%                  | 59,000            |
|                              | Insufficient broadband speeds; Other digital literacy, attitudes and household circumstances identified using Mosaic.                         | 7.8%             | 180,000          | 18.1%                 | 2,232,000         |
|                              | Income below threshold; Other digital literacy, attitudes and household circumstances identified using Mosaic.                                | 44.0%            | 1,016,000        | 15.1%                 | 1,862,000         |
|                              | Income below threshold; Insufficient broadband speeds; Other digital literacy, attitudes and household circumstances identified using Mosaic. | 8.5%             | 196,000          | 2.7%                  | 339,000           |
| <b>All households</b>        |   | <b>100.0</b>     | <b>2,309,000</b> | <b>100.0</b>          | <b>12,348,000</b> |

In combination, these attributes were used to select a subset of household clusters derived from Mosaic. Households without any of the above characteristics or who were less likely to exhibit this behaviour were identified as being unlikely or unwilling to switch to a dynamic time of use tariff. However, it is not currently possible to separate out in the analysis the specific missing individual attributes associated with why a consumer accessed an offer or not. In the table below, not having these characteristics has been included in one category 'Other digital literacy, attitudes and household circumstances identified using Mosaic'. This has been categorised in the analysis below as having multiple factors.

The majority of households who were identified as being the least likely to take up an offer did so due to multiple factors. This goes some way towards explaining why some of the mitigation options explored above had limited effect in improving likelihood of taking up an offer.

For the non-fuel poor households not able to take up the offer, 60% missed out through lacking digital literacy, attitudes and household circumstances suitable for a dynamic use tariff (as identified through the Mosaic household data). For fuel poor households, income levels played a more significant role in shaping why households were unlikely

to access this offer: the uncertainty that these new forms of energy tariffs are likely to have on household energy bills is least likely to appeal to those on lower incomes.

Another issue that found to prevent participation is low quality internet connections available at people's homes. Not having reliable access to an associated smart phone app would make it hard for people to keep track of the changing tariff, make informed choices about their energy usage choices or track the effect of the tariffs on their energy costs. This constraint predominantly affected non-fuel poor households.

#### **4.4.5 Mapping the location of different energy consumer groups**

---

A significant strength of the datasets that underpin the Consumer Classification Model is the ability to map different types of households at address level. The following set of figures presented below provide an example of this mapping potential, showing the different types of smart energy consumers in Bristol and Oxfordshire (Figure 10) and the consumers likely to access an individual offer – EV smart charging with ToU tariff – at different stages of adoption (Figure 11).

As Figure 10 shows, there is geographic clustering of different adopter types, with early adopters mainly clustered in more urban areas, inner city locations and town centres. Later adopters and those not accessing any offers are typically those living in suburbs and more rural areas, although there are variations to this overall pattern. Similar patterns of clustering is evident for individual offers, as shown in Figure 11.

Mapping has been conducted across the whole of England. The visual outputs show in figures below exemplify the type of mapping that can be generated to show the results of analysing a single offer or multiple offers (i.e. different consumer types). Data has also been aggregated to higher levels of geography including Lower Super Output Areas (LSOAs) and local authority districts, providing a visual summary of different types of consumers across the country.

**Figure 10: Maps showing locations of different energy consumer types in Bristol and Oxfordshire**

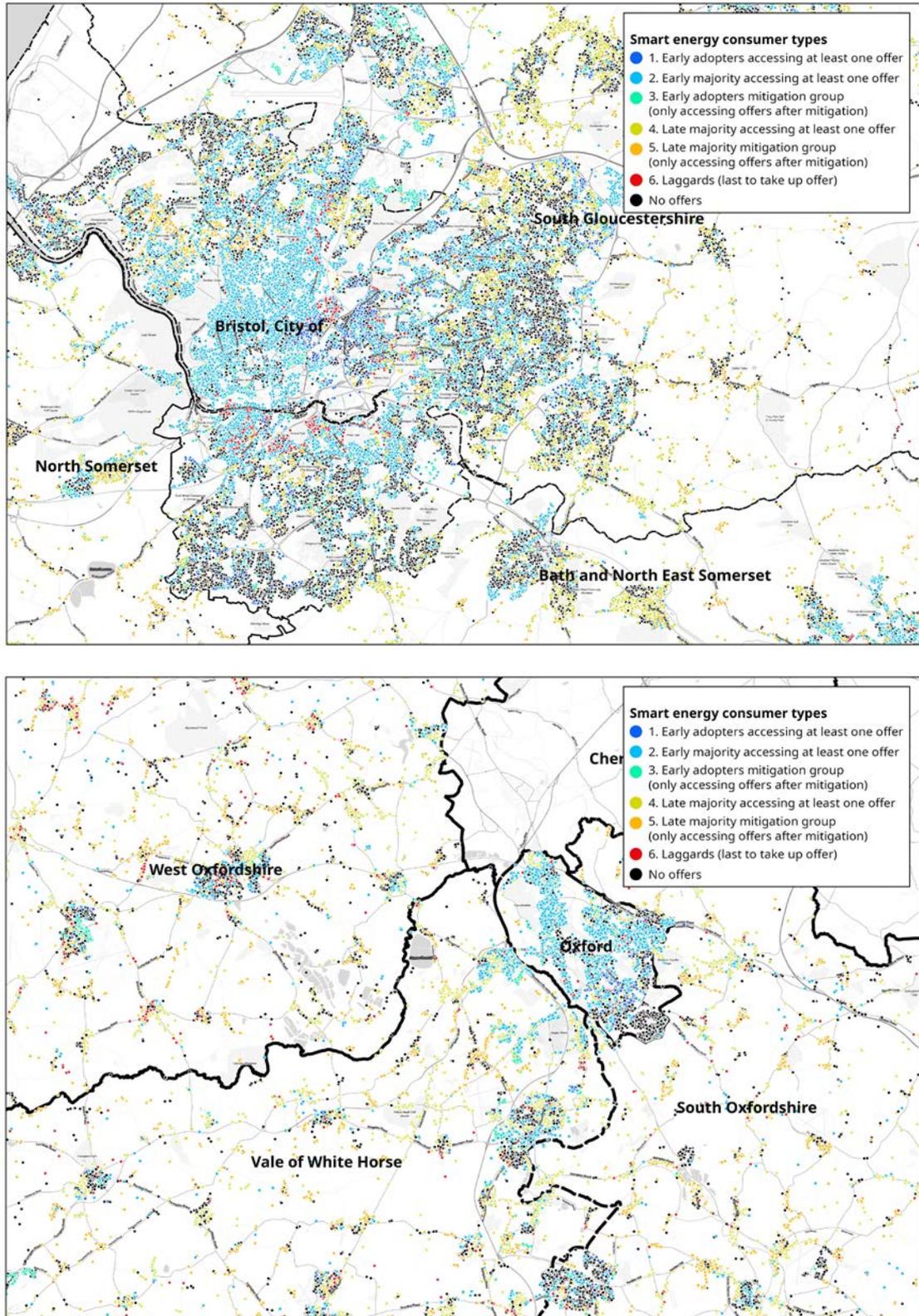
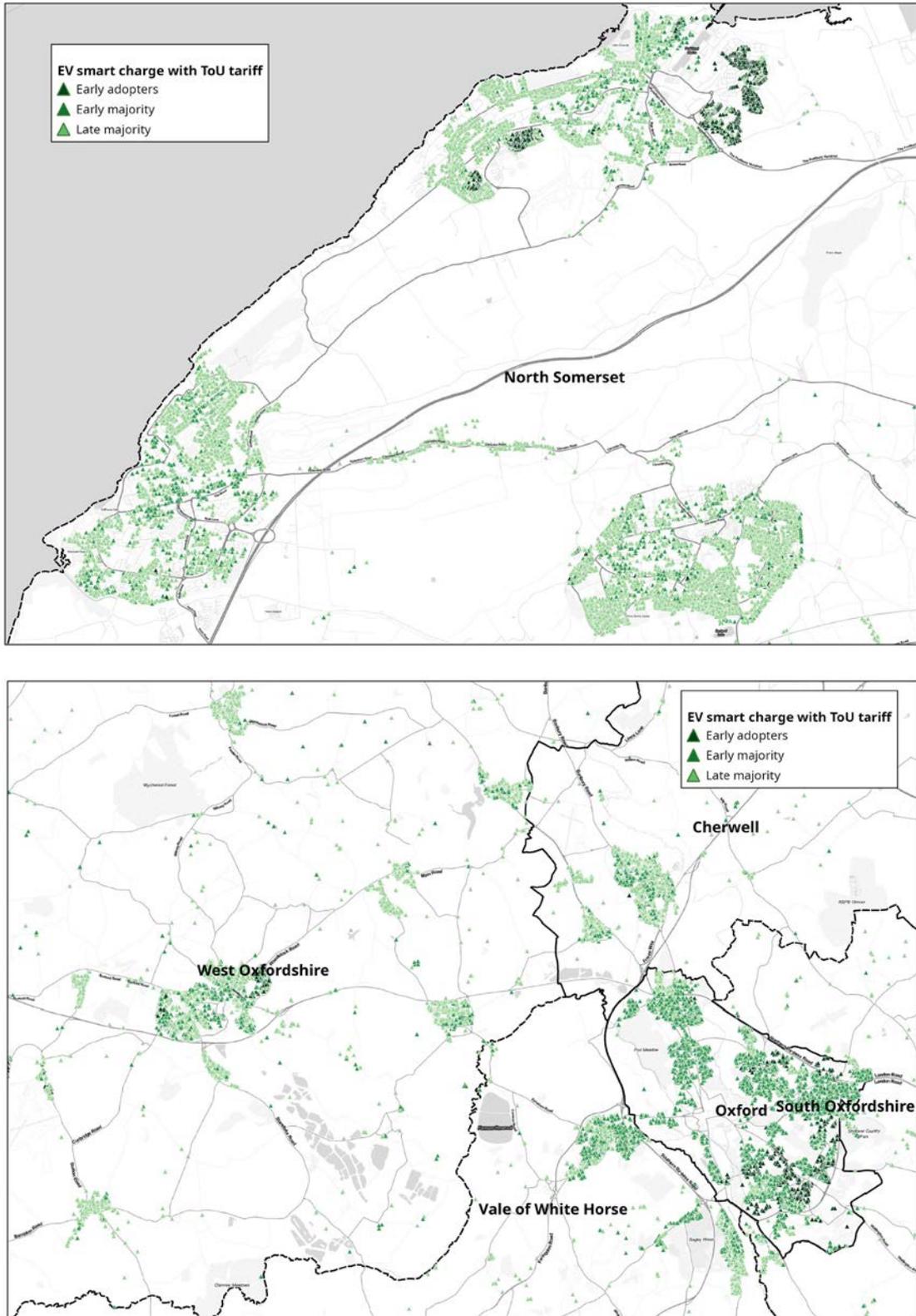


Figure 11: Maps showing locations of different adopters for EV smart charging offer with ToU tariff (West of England and Oxfordshire)



## 4.5 Summary of Consumer Classification Model findings

A rich set of address-level data, which relate to key characteristics and capabilities identified in the Capability Lens was compiled to developing the first version of the Consumer Classification Model. The model has been designed so that the outputs from the Offer Profiling Tool can be directly used to identify, quantify and locate these households across England.

The illustrative results presented above demonstrate the Model's potential power in predicting whether and how different consumers will participate in the offers associated with the transition to a smarter energy system. In particular, it has the potential to reveal, profile and map the types of households who are most – or least – likely to be able to participate.

The specific results of this analysis are subject to the significant caveat that they depend on the accuracy of the characterisation of the offers using the Offer Profiling Tool and of the association between attributes and consumer data in the Consumer Classification Model. This includes the positioning of consumers on the adoption curve. The analysis also assumes mitigation interventions as presented are fully effective.

Acknowledging this caveat, the results do suggest that the smart energy market with the sorts of offers currently conceived is likely be more accessible to less vulnerable and better off households living in more urban areas. Conversely, the results also suggest that most of the households which would currently be categorised as being vulnerable are likely to be in the 'left behind' group who are unable to access the smart energy offers that are emerging on the market.

## 4.6 Next steps

As discussed earlier, the work outlined in this section summarises the development and outputs from the first version of the consumer classification model. Further amendments and enhancements are planned for future versions. It is recognised that a number of improvements could be made to the Consumer Classification Model and its application. These include core updates to the model mechanisms as follows:

- Researching, deriving and incorporating more data into the core datasets that underpin the model. Such data could enable better understanding of network constraints within a specific area or the suitability of dwellings for certain smart energy and low carbon technologies such as EV charging points, solar PV panels or electric heating systems. Further social, economic, attitudinal and behavioural data would also enhance the precision of the model.
- Researching and integrating more complex modelling of offers to recognise a fuller set of financial and other valued benefits potentially achievable by households who take up smart energy offers (i.e. beyond participating in smart energy offers and the benefit of feeling involved and contributing to a smarter future energy system).

- Adding further functionality to the model, or enhancing existing scenario functions. For example, significant value could be added to the model by enhancing the way offer-specific mitigation interventions are simulated by better replicating real-world policy or regulation scenarios.

In addition, further work is needed to validate the assumptions behind the model and trial the model outputs and analysis in real world situations. This includes:

- Verifying the characteristics of consumers who are most capable and most willing to take up new smart energy offers and comparing reality with the model outputs. In particular, the model inputs have depended on the subjective assessments undertaken with the Offer Profiling Tool, and it is necessary to understand how well these actually capture the characteristics of people who are taking up the offer and able to benefit from it.
- Understanding the relationships between the available household-level data chosen to represent the attributes in the Capability Lens and actual household data (particular areas where the tool is reliant on estimated data or small scale data include energy use profiles and demand flexibility attributes).
- Empirical research to understand whether different types of households take up offers as predicted by the Offer Profiling Tool and Consumer Classification Model.
- Engage with community level programmes to gauge how useful and accurate the categorisation of households through the Consumer Classification Model can be at assisting in local delivery of smart energy market technologies and projects.

## 5 Emerging guidelines for smart and fair outcomes, our recommendations and next steps for Phase 2

In Phase One of *Smart and Fair?* we have developed an analytical framework and created tools to enable ourselves and others to:

- Understand better the capabilities and characteristics which are being required of consumers to participate in the smarter energy system.
- Analyse individual and sets of smart energy offers and opportunities to reveal the particular requirements they place on consumers.
- Look across the emerging market to see which consumers are likely to be able to join in and benefit and which are likely to be left behind.
- Consider the types of interventions which might be appropriate to reduce the likelihood of being left behind or reduce the impact on more vulnerable consumers of not participating.

This section examines

- a. How this framework might be further applied to understand more fully the potential distributional impacts of the transition to a smarter energy market as it gathers pace, the changing nature of vulnerability in a smarter system, and the characterisation of different localities and communities.
- b. Key questions posed by the findings to date about how to balance the need for smart innovation and the importance of achieving a fair outcome over time (including why fairness can't be left to the market).
- c. Implications for the design and delivery of mitigation to reduce the risk of negative distributional impacts.
- d. Guidelines for practitioners to increase the chances of fair outcomes being achieved more routinely.
- e. Recommendations to policy-makers, regulators, energy system practitioners, and consumer advocates on how to support mitigation to widen participation, protect consumers to reduce harm, and improve understanding to achieve more inclusive markets.

- f. Our plans for Phase Two of *Smart and Fair?* in relation to validation of the assumptions embedded in the framework, further development and application of the tools and techniques, market monitoring, practical pilots to design and test specific mitigations, further work to improve understanding and inform policy and regulatory developments.

### 5.1 **The potential of this framework to reveal smart energy ‘winners’ and ‘losers’, highlight new sources of vulnerability, and characterise communities**

We believe the analytical framework and tools developed in Phase One have significant potential to be developed further so that they can be used to examine other important aspects of the transition to a smarter energy system.

In future, as the potential nature and scale of benefits available from different types of smart energy offer become clearer, this framework can be used to assess the potential financial distributional impacts between participants and non-participants for both individual and multiple offers.

More detailed and reliable information on the value and costs of offers could be used to expose how the shift to a smarter market is likely to redistribute the costs and benefits of being an energy consumer between different types of consumer. The framework, particularly the Consumer Classification Model, would then allow the resulting ‘winners’ and ‘losers’ – in financial as well as the ‘participation’ terms detailed here – to be characterised in considerable detail, socio-demographically and geographically.

This could reveal, for example, which are the groups of more vulnerable consumers who risk being most disadvantaged by different types of smart energy innovation and associated market developments and in what ways. It could also show how these vulnerable consumers distribute geographically, which participation-enabling attributes such vulnerable consumers particularly lack, and therefore what sorts of mitigation might be needed by different types of vulnerable consumer to avoid or mitigate these negative impacts.

Such analysis could also help to identify which consumer capabilities and attributes are likely to become particularly important to the ability to participate meaningfully in a smarter energy system. Some of these can be considered new in that they are not required to participate in the current ‘dumb’ energy system: a good example would be having decent quality broadband and in-home Wi-Fi. These (or more specifically their absence) represent potential new sources of energy-related vulnerability which need to be reflected in strategic thinking and practical work being done to address consumer vulnerability across the energy market. This is particularly relevant for energy suppliers, energy networks and the regulator Ofgem.

We also believe that the analytical framework, and the Consumer Classification Model in particular, can be used to characterise a locality – from a single street or small group of houses to a village or neighbourhood to a town or city – in terms of the sorts of smart

energy offers its population is likely to be able to take up (and how different types of consumer distribute within the locality). This would be done by using the framework in reverse to the way in which it has been applied here (as described in Section 4). This analysis should also be able to inform the design and targeting of interventions to enhance the take up of smart energy offers and address energy-related vulnerabilities.

It could also help in the design and targeting of specific types of smart energy offer to reflect the characteristics of consumers in that locality (e.g. as considered for Project LEO, [www.project-leo.co.uk](http://www.project-leo.co.uk)). This should be of particular interest to electricity distribution network operators exploring what sorts of demand-side initiatives might be suitable to help manage network constraints or other network management challenges in a given area.

## 5.2 Smart and Fair by when? Securing innovation and fairness over time (and why it can't be left to the market)

By applying the concept of the technology adoption curve to frame some aspects of consumers' likelihood of taking up an offer, we have introduced a sense of how the picture of participation might change over time.

This helps to avoid the risk of rushing to judgement about the state of 'fairness' of an emerging smarter energy market which requires innovation in order to get smarter. By its nature, such innovation will inevitably involve only a small number of 'pioneers' and 'early adopters'. It therefore leaves behind at the early stages anyone who is not keen or able to participate in innovation. Early verdicts about any disparity between who is 'keeping up' (a relatively small group) and who is being 'left behind' (everyone else) would therefore be of rather limited value and potentially unhelpful.

Given many innovations feature risk and uncertainty (about technology performance, benefits available, value for money etc.), this tendency for the more innovation-oriented and financially secure to act first is not problematic. Indeed, it is probably better that vulnerable households, few of whom have such orientation or financial resilience, are not taking such early stage risks as they can ill afford to see them realised.

If the innovation proves successful (delivering reliable performance and well-defined benefits), then the associated risks will diminish and the willingness and ability to embrace innovation will no longer be a required characteristic to participate. Other types of household (who possess all of the other required characteristics for that offer) will then be more likely to start to participate.<sup>8</sup>

---

<sup>8</sup> This said, many (some say most) innovations do not cross into the mainstream like this – failing to shift beyond a 'pioneer' niche or to find the finance required to reach a much larger market. The Offer Profiling Tool and Consumer Classification Models could be used to help to explain (and potentially reduce) such failures by revealing the nature, prevalence and distribution of other consumer capabilities and attributes required for participation.

However, this does raise some important questions about timescales and where responsibility for achieving 'fairness' sits. These have emerged over the course of Phase One and need to be considered and addressed. The first relates to the time over which 'fairness' should be assessed:

*Over what timescale should we assess the distribution of the take up of smart energy offers (and their associated benefits and costs) and assess its 'fairness'?*

If we know that early take-up will be skewed towards those willing to be innovative with sufficient financial resilience (and to accept the associated risks), it would seem somewhat perverse to expect or require explicit 'fairness' from the outset.

Indeed, we need those willing to develop such offers and the consumers willing to take risks by taking them up to do so. Otherwise the innovative smart energy offers will not come forward and the energy system will become smarter far more slowly (and potentially at higher eventual cost).

That is not to say that revealing the scale and nature of such skewed take-up will not prove instructive even at an early stage in market development in terms of understanding: (a) how take-up might develop over time; (b) who will still not be able to participate (because they lack other required attributes) even when the offer's profile shifts away from requiring an appetite for innovation, and; (c) what interventions might enable greater participation as an offer becomes more 'normal' (potentially also helping the innovative offer actually become normal).

Such analysis would create predictions about future participation which could be assessed against market information over time. In addition, it could inform the design and testing of interventions to enable wider participation. These interventions may have the added benefit of increasing the take up of offers so that they succeed in becoming 'normal', something which many potentially societally valuable innovations of the past have failed to achieve.

This 'timescale' question – essentially 'by when must things be 'fair'? – is associated with two other closely related questions which have arisen during Phase One.

*Should an assessment of 'fairness' relate to one offer or to many offers?*

*Does every offer need to be (eventually) 'fair'? If not, across how many offers should the distributional impacts and 'fairness' be assessed?*

Clearly, the *Smart and Fair?* analytical framework can be applied to single offers and multiple offers to reveal who gets to participate over time in each offer in isolation and in some or all offers in combination. And, by exclusion, the analysis predicts who will not be participating in each offer and who is left behind by all offers.

As information about the actual benefits and costs of different offers (in isolation and in combination) becomes available, such analysis will also be able to forecast the

financial distributional impacts of each offer and all offers across consumers, revealing likely ‘winners’ and ‘losers’ and the scale of their wins or losses.

But where does the responsibility lie for addressing or mitigating the negative impacts revealed by such analysis? These questions go to the heart of the tension with which the *Smart and Fair?* programme is grappling.

We need to stimulate the innovation required to achieve a smarter energy system that supports more rapid, more cost-effective decarbonisation.

And, to sustain public support for change and achieve socially just outcomes, we need to ensure that the opportunity to participate in this smarter energy system is widely available and those not participating are not unduly disadvantaged (particularly those who are least able to cope with such additional disadvantages).

Of course, there are several grounds on which an individual offer could potentially be judged as ‘fair’:

- By its overall inclusiveness in enabling a diverse range of consumers to take it up, including through enhancements over time.
- Through the development of tailored products or services which specifically enable participation by consumers otherwise at risk of being left behind.
- By contributing to available choice within a growing market, such that different households can choose from a range of offers that best fit their circumstances, capabilities and preferences.

Our focus here is the first two of these points and what can be expected of individual offers, particularly at the early stages of market development.

This would point to requiring that every organisation offering a smart energy service consider what is possible within their individual offer to make it more inclusive. However, there will undoubtedly be a point for each offer at which the costs and complexity of doing this will make the offer unviable.

It is not clear exactly where this point lies for each offer and therefore what the ‘offeror’ could reasonably be expected to do to improve inclusivity without undermining viability. There is almost certainly no blanket rule that could be applied to all offers, particularly as the value of, and margins available from, different offers remain uncertain in such a new market.

Furthermore, many of the factors influencing whether a consumer is able to take up an offer are beyond the control of the offeror; some – such as the availability of high speed broadband or the regulation of the private rented housing sector or even having off-street parking available to charge an EV – sit outside the energy system altogether.

At this early stage of market development (with relatively low participation rates), the appropriate response within the market may be simply to ensure that offerors (a) have assessed the characteristics their offer requires of participants (and what their typical participants therefore look like) and (b) can describe what interventions would help more people – and a more diverse range of people – participate (if such interventions were to be brought forward). What this would involve is described in more detail in the **Guidelines** in Section 5.4 below.

This reality suggests that it would be unreasonable and unhelpful to expect or require ‘smartness’ to align with ‘fairness’ at the micro level of each offer; we will not secure a smart energy system if we do.

However, this brings with it an uncomfortable (but perhaps obvious) corollary.

***If we can't expect to require or deliver fairness in the particular of each smart energy offer coming into the market, we can't expect fairness to be achieved across the generality of offers in the market.*** That is because we would only be relying on the combined efforts of the ‘offerors’ to achieve this, none of whom are required (because they probably are not able) to ensure each of their own offers result in fair participation.

As the analysis in Section 4 above shows, we should not assume ‘smart’ and ‘fair’ are ready and easy companions, even though they will need to become such to secure lasting public and political commitment to a smarter energy system.

The implication of this is that we should not expect that the market in smart energy offers will lead to a fairly distributed level of participation in a smarter energy system or of the costs and benefits associated with doing so.

To achieve a fairer outcome for a smarter energy system will require deliberate efforts – from beyond those organisations trying to deliver smart energy offers – to design and implement interventions to support greater and wider participation (to reduce the numbers ‘left behind’) and to protect those who, in spite of such efforts, remain ‘left behind’ and unable to bear the costs of not participating.

In addition, as mentioned above, it will require effort by agencies beyond the normal scope of the energy system – from policy makers responsible for regulation of private and social landlords to those delivering high speed broadband – to adjust their priorities and practices to contribute to a fairer smart energy market. As revealed by the Capability Lens and the Offer Profiling Tool, this is because so many of the capabilities and attributes associated with any consumer’s ability to participate in smart energy offers are associated with the nature of their housing, their income, the quality of telecoms available in their area (and affordable to them) etc.

Such interventions – from ‘within’ the energy system and to address these wider issues – should be seen as a necessary cost for delivering a smart and fair energy system that retains public and therefore political support and enables the decarbonisation required by the UK’s commitment to achieving net zero carbon emissions by 2050.

The responsibility for ensuring these efforts take place should clearly sit with BEIS and Ofgem (including orchestrating relevant contributions from other government departments and agencies and the Welsh and Scottish Governments).

The efforts ‘within the energy system’ (but beyond individual offerors) could potentially be funded through a ‘smart energy participation support’ levy and principally orchestrated by DNOs, given their monopoly position and central role in system resilience, their emerging role in enabling smarter energy services on local networks and need to understand wider market developments, their place-based operations, their knowledge of vulnerable consumers and associated relationships with agencies who can advise and support such consumers.

### 5.3 **Developing interventions to increase participation and widen access, reduce the risk of consumer harm, and mitigate negative distributional impacts**

It is clear from the analysis in Section 5.2 above that interventions will be necessary to ensure that the benefits of participation in a smarter energy system are distributed widely and, as far as possible, fairly.

#### **A range of mitigating interventions – which need to be piloted and evaluated**

In Section 4.3.3 above we described and then modelled the effect of various intervention options which had been identified as a way to address key gaps in consumer attributes to enable more consumers to participate in the offers being considered.

The modelling applied a simplistic assumption that each mitigation measure is 100% effective in enabling each consumer lacking the particular attribute addressed by the mitigation measure (but having all the other required attributes) to then take-up the offer. For example, requiring private landlords to permit the installation of smart energy technologies by tenants meant that the offer profile then included private rented homes. In the modelling, that led to all private tenants who had all the other required characteristics then taking up offers which required such installations.

In the real world, 100% uptake in response to a mitigation measure is highly unlikely: it will be more complicated and less successful than that. Designing, targeting and delivering mitigation measures to achieve wider and more inclusive participation in smart energy offers will require careful attention and, in the early stages, testing and evaluation to reveal what does and does not work.

The discussion in Section 5.2 above suggests that mitigating interventions may be more usefully considered to increase participation and widen access across a range of offers, rather than for individual ones. It also exposes the need for interventions to be made from ‘beyond the energy system’ to address the wider circumstances of consumers’ situations which influence their ability to take up offers, including, for example, their housing tenure or whether they have access to high speed broadband.

That said, given there is no evidence available of the reach or effectiveness of different types of mitigating interventions, an immediate priority is to test interventions in reasonably controlled settings. Potential mitigation interventions should be piloted and evaluated in association with specific smart energy offers so that their effects can be measured with some precision.<sup>9</sup>

The analysis done in Section 4 suggests that, at this early stage of market development, interventions may be best targeted at and tested with those consumers identified as potential ‘early adopters’ but who are not yet participating because they lack other essential attributes for the offers in question. This would help ensure that ‘appetite for innovation’ was not a decisive factor in any trial.

Mitigation interventions to increase and widen participation may usefully be considered in three different clusters:

- 1) Interventions to support consumers by providing or making up for key missing capabilities and attributes (e.g. grants or loans for ‘smart’ technologies to make up for lack of access to capital, under-writing of technology/offer performance to reduce perceived risk of participation, access to advice to improve knowledge and support good choices)
- 2) Interventions to change the system (or an individual offer) so that some capabilities and attributes are no longer essential (e.g. improving trust and confidence in the market – see ‘Reducing the risk of consumer harm’ section below, reducing minimum thresholds for participation in flexibility and demand-response services, private and social landlord regulations to require improvements or allow tenant participation)
- 3) Interventions from ‘outside’ the energy system which increase the likelihood that required capabilities and attributes are more widely available and so no longer distinguish participants from non-participants (e.g. ubiquitous high speed broadband and high quality 4G mobile signals).

### **Reducing the risk of consumer harm**

---

There are also interventions required to address the risks of consumer harm that will emerge as the market develops – from consumers making poor choices and taking up offers which are not in their interests (i.e. mis-bought) to consumers being offered services which are not suitable for them (i.e. mis-sold).

In the latter camp would also be consumers not being offered new services or tariffs which are suitable and advantageous for them (i.e. missed out). This could be because, for example, they already have an energy profile which is ‘system friendly’ – such as a pensioner couple who routinely do their washing on sunny days when PV production is high. In these circumstances, there is no additional system benefit of them taking up a ToU tariff (because the tariff would not trigger them to change their already system-friendly energy use profile).

However, there would be an additional benefit to the consumer of them doing so – because they would start to receive the financial benefits of their system-friendly profile directly in a ToU tariff. In a half-hourly settled domestic market where the system-friendly consumer does not take up a ToU tariff, their energy supplier will gain for themselves the financial benefits of their consumer's system-friendly energy use (benefits which had previously been socialised). This is a different, but very real, type of unfairness to the others explored here. In this case, the unfairness is found in consumers not getting their fair share of the benefits which their behaviours are providing for the energy system.

Addressing the first risk of harm – consumers making poor choices – typically requires good and reliable market wide information, well-structured comparison sites (which capture and reflect the key capabilities and attributes of different offers so that consumers can 'match' themselves well), and tailored advice and support for those who are least able to cope with any harm. Such assistance is currently available to some extent (e.g. Big Energy Saving Network) but these programmes need to be upgraded and expanded so that vulnerable consumers can navigate and participate in the more complex smart energy market.

Dealing with the second risk of harm – consumers being offered poor deals or not being offered the most suitable deal for their circumstances – needs a different approach which puts the onus on energy suppliers to make appropriate offers.

To address this harm, Ofgem should interpret their requirement on energy suppliers to 'treat each customer fairly' to include ensuring that any ToU tariff offered to a vulnerable consumer is appropriate and not disadvantageous to that consumer: 'Right deal, right customer'. This should not prove onerous, given that the energy supplier will have access to the consumer's smart meter data and, particularly for more vulnerable consumers, should also have an understanding of other household capabilities and attributes. Ofgem should also police this requirement rigorously, undertaking market monitoring and sampling above and beyond regulatory reporting, to root out and address poor practices.

Ensuring suppliers and other 'offerors' conform with the Guidelines outlined in Section 5.4 below will ensure information about offers and the consumer capabilities and attributes they require is routinely available.

These consumer harm reducing interventions should also help build trust in the smarter energy market more generally. That would in turn reduce the extent to which 'trust' is an important attribute for participation.<sup>10</sup>

---

9 In designing interventions, it may be worth using the Offer Profiling Tool and Consumer Classification Model to consider (a) what capabilities and attributes participation in the intervention would require and which consumers that is likely to work for and, in reverse, (b) to identify a set of consumers whose participation is sought and identify the capabilities and attributes they lack for the offers in question and then consider how that lack may be mitigated.

10 For further discussion of consumer protection in a smarter energy market, see work by Citizens Advice at [www.citizensadvice.org.uk/about-us/policy/policy-research-topics/energy-policy-research-and-consultation-responses/energy-policy-research/setting-out-principles-for-a-future-energy-market/](http://www.citizensadvice.org.uk/about-us/policy/policy-research-topics/energy-policy-research-and-consultation-responses/energy-policy-research/setting-out-principles-for-a-future-energy-market/)

### **Mitigating negative distributional impacts for those least able to cope with them**

---

It is highly likely that, however successful the interventions described above turn out to be, there will still be some consumers who do not participate in the smarter energy system and do therefore get ‘left behind’. While there is a general question of ‘fairness’ here (shouldn’t everyone have the opportunity to participate?), we are principally concerned about those consumers left behind who do not respond to mitigating interventions and who are least able to cope with the negative consequences, particularly the higher energy bills than they would have if they were participating in appropriate offers.

Protecting these consumers whose circumstances in prevailing market conditions make them unable to participate in the smarter energy market should be seen as a priority for policy-makers and regulators. This is to ensure that both (a) some of the most vulnerable in our society are not further disadvantaged by changes introduced to achieve a wider societal goal (decarbonisation) and (b) the smarter energy market is explicitly addressing unfairness otherwise being generated in its operation.

That said, and in spite of the analysis in Section 4.3, it remains too early in the development of a smart domestic energy market to be able to be clear about either (a) the identity of those being left behind and the extent of their vulnerabilities that leave them unable or unwilling to participate and (b) the scale of the detriment being experienced as a result. These will only be revealed by further information drawn from active market monitoring and further analysis of participation rates and benefits being realised.

The solution for these vulnerable ‘non-participants’ may be for BEIS and Ofgem to establish a ‘non-participant’ basic tariff. The charges for this could perhaps be determined in a similar way to the current standard variable tariff price cap. The eligibility for such a tariff should be determined by further analysis of the consumer vulnerability characteristics most typical amongst those which the market monitoring is showing are being left behind.

---

<sup>10</sup> For further discussion of consumer protection in a smarter energy market, see work by Citizens Advice at [www.citizensadvice.org.uk/about-us/policy/policy-research-topics/energy-policy-research-and-consultation-responses/energy-policy-research/setting-out-principles-for-a-future-energy-market/](http://www.citizensadvice.org.uk/about-us/policy/policy-research-topics/energy-policy-research-and-consultation-responses/energy-policy-research/setting-out-principles-for-a-future-energy-market/)

## 5.4 Guidelines for smart energy practitioners and commissioners: a first draft

We have concluded here that those offering smart energy offers cannot be expected to take by themselves all the necessary steps to ensure fairly distributed participation in their offers. That could create a burden that would put at risk the innovation needed to achieve a smarter energy system.

Nevertheless, as indicated in Section 5.2 above, we can set out a series of steps which those making smart energy offers to domestic consumers – or, like system operators (at grid and distribution level), commissioning or creating markets for such offers from others – should be expected to take and to document transparently and publicly.

Doing so across the market would greatly assist the development of interventions to increase market participation levels, including for vulnerable consumers. It will also inform future assessment of the potential distributional impacts of different sets of offers becoming commonplace and what might be needed to protect those at most risk of being left behind.

In addition, this information (particularly from steps 1 and 2) should improve the quality of listings by offer comparison sites and associated consumer suitability assessments as they start to feature smarter energy offers (including different types of time of use tariffs).

Consistent market-wide adherence to these steps would also improve the quality and value of future market monitoring. It would enable more accurate predictions of take up and participant characteristics for each type of offer coming forward to guide monitoring activity and to test against actual market behaviours.

### 1. Articulate clearly the terms of your offer

---

This should include: any technology required (and whether provided/included); the potential costs and benefits and their origin (e.g. avoided system charges, grid/network services, half-hourly variations in wholesale energy costs etc.); how the scale of benefits achieved relate to the behaviours/responses of the consumer and/or their equipment; the nature and causes of risks to consumer, including shortfall in anticipated benefits and any offer-associated technology failure or underperformance.

### 2. Describe the capabilities and attributes which your offer requires of participating consumers

---

The *Smart and Fair?* Offer Profiling Tool is designed to assist this process; our findings using the beta-version of the Offer Profiling Tool presented in Section 3 is that this exercise is most useful when the user starts with a clear articulation of the offer and when different users compare and discuss their resulting offer profiles to arrive at an agreed profile.

---

**3. Consider and articulate how you anticipate both 1. and 2. might change over time (e.g. within one year, two years, beyond)**

---

As the offer becomes more proven and participation therefore less risky, how might the costs of participation change (for example, in terms of the price of required technology)? Are the available benefits likely to change (for example, as markets in grid services develop and mature or wholesale markets change with higher volumes of renewable generation)? How would these changes, and potentially the greater market familiarity with the type of offer, affect the capabilities and attributes required of participating consumers (e.g. available to lower income households, less dependent on attitude to risk etc.)?

**4a. Understand the nature and numbers of consumers who have the right capabilities and attributes to participate in your offer now and over time, and****4b. Identify the most significant missing capabilities and attributes for those who do not, including vulnerable households**

---

The *Smart and Fair?* Consumer Classification Model (not available in the public domain) is designed to enable this by characterising every consumer household according to the range of capabilities and attributes included in the Offer Profiling Tool. Applied appropriately, the Model can reveal the number and nature of households which have the required capabilities for participation (and how they distribute geographically). It can also detail the reasons (in terms of missing characteristics and attributes) why other households are unable to participate. This in turn indicates what number and type of households might be assisted by interventions designed to address such gaps.

The Consumer Classification Model analysis can be tuned to focus on consumers with different types of vulnerability. This will expose the particular challenges – and the particular potential mitigating interventions – associated with increasing participation by such consumers.

**5. Describe the types of interventions which, if taken, would be most likely to enable wider participation and those which, if taken, would specifically support more vulnerable consumers to participate**

---

Drawing on the analysis from Steps 4a and b above and the considerations outlined in Section 5.3 above, it should be possible to describe a range of mitigating interventions which could address key gaps in attributes which are preventing consumers, and more specifically, vulnerable consumers, from participating in the offer.

Highlighting these potential interventions for each offer will help to inform the design, development, targeting and delivery of interventions across the market by whatever agencies are identified and supported to implement them.

## 5.5 Recommendations to policy-makers, regulators and practitioners

On the basis of the analysis and thinking we have undertaken in Phase One with the input of expert stakeholders, we have identified a set of 21 recommendations we believe will help to ensure that the shift to a net zero energy system is both *smart and fair*.

### Recommendations for BEIS

---

- 1 Working with Ofgem, ensure the policy and regulatory interventions to reduce the risk of consumer harm from smarter energy offers, as described in Section 5.3 above, are introduced promptly and properly funded.
- 2 Ensure that all those offering smart energy offers to domestic consumers follow the Guidelines outlined in Section 5.4 above. Require Ofgem to oversee the timely publication of the resulting information.
- 3 Support Ofgem with the introduction of a ‘Smart Energy Participation Support’ levy (raised through DNO charges) to fund appropriate interventions to enable greater participation in the smart energy market, with a particular focus on supporting participation by more vulnerable consumers otherwise at risk of being left behind.
- 4 In partnership with Ofgem, undertake regular distributional impact analysis across the range of smart energy offers and opportunities in play or emerging in the domestic energy market, initially to predict ‘winners’ and ‘losers’ and subsequently (as more information becomes available from effective market monitoring) to reveal what is happening in practice.
- 5 Permit Ofgem to introduce regulatory oversight of third parties active in the smart energy market, including EV charging providers, aggregators of demand side flexibility services, peer-to-peer and local traders.
- 6 Support (with funding and evaluation) a programme of pilot interventions to increase take-up and widen access to participation in smart energy offers.
- 7 Ensure the prompt completion of the domestic smart meter roll-out so that this essential enabler for participation in nearly all smart energy offers is widely available.
- 8 Engage with other key responsible parties to ensure they understand and follow through on what they can do to enable wider participation in a smarter energy market, specifically for: performance standards for energy-using appliances (within BEIS); housing sector regulations and building standards (Ministry of Housing Communities and Local Government, Scottish Government and Welsh Government); broadband and mobile telecoms provision (Department for Culture Media and Sport and Ofcom).

### Recommendations for Ofgem

---

- 9 Working with BEIS and other relevant authorities (e.g. devolved nations), ensure the interventions to reduce the risk of consumer harm from smarter energy offers, as described in Section 5.3, are introduced promptly and properly funded.
- 10 Enforce BEIS requirement (see Recommendation ii) that all those offering smart energy offers to domestic consumers follow the Guidelines. Oversee the timely publication of the resulting information.
- 11 Clarify that the requirement on energy suppliers to ‘treat each customer fairly’ extends to offering them appropriate smart energy offers (including suitable ToU tariffs) and then rigorously monitor and enforce compliance.
- 12 Sponsor active and sustained market monitoring of the smarter energy market as it emerges, revealing who is taking up what offers (and who is not participating), the scale and nature of benefits being realised, and which consumers are receiving what support to participate.
- 13 Introduce a ‘Smart Energy Participation Support Levy’ in RIIO-ED2 funding settlement (see Recommendation iii) and encourage DNOs to use innovation allowances to design, test and evaluate interventions to enable wider participation in smart energy initiatives associated with innovative approaches to network management.
- 14 Work with energy networks, energy suppliers and consumer advocates to review how definitions of consumer vulnerability and associated risks of harm should be updated to reflect potential new risk factors introduced by the transition to a smarter energy system.

### Recommendations for energy system practitioners (energy suppliers, network operators, smart energy innovators, consumer support and advocacy agencies)

---

- 15 Follow the Guidelines and make the resulting assessments available (in line with Ofgem’s requirements).
- 16 For those advocating a smarter energy system and associated markets, acknowledge that the development of an inclusive and fair smart energy market is crucial to the long term health and legitimacy of the market as a whole. Contribute positively to its achievement. Uphold the need for ‘fair’ as well as the need for ‘smart’.
- 17 For those championing the consumer interest, ensure that the interests of current and future generations of consumers in securing the societal benefits of a smarter energy system (and the associated lower cost path to net zero carbon emissions) are reflected in advocacy for better consumer protections and interventions to enhance participation in smarter energy markets. Uphold the need for ‘smart’ as well as the need for ‘fair’.

- 18 Actively and constructively engage with initiatives to pilot and test interventions to increase and widen participation in smart energy offers.
- 19 Contribute willingly to Ofgem-sponsored market monitoring, providing data on participation rates and the benefits and costs being experienced by different types of customer.
20. DNOs should use innovation allowances to design, test and evaluate interventions to enable wider participation in smart energy initiatives associated with innovative approaches to network management.
- 21 Consider supporting and participating in Phase Two of CSE's *Smart and Fair?* research programme.

## 5.6 Our plans for Phase Two of *Smart and Fair?*

We are developing our plans for Phase Two of our *Smart and Fair?* programme. Our initial thoughts are outlined below. These reflect the findings, insights and progress we have made in Phase One and include the 'next steps' on the Capability Lens, Offer Profiling Tool and Consumer Classification Model outlined at the end of Sections 2.6 and 4.6.

In Phase Two, we will be shifting from the primarily theoretical approach adopted in Phase One to one more rooted in practical applications, real market activity and active policy analysis and advice. We anticipate that this will be a significantly larger programme of work than Phase One which we hope would have a truly meaningful impact for consumers at this key moment in the transition to a smart, decarbonised energy system. We would be interest in readers' feedback on these plans.

***Please note these plans are subject to CSE securing sufficient funding to undertake the programme and its different elements.***

### a. Validating outputs from Phase One

---

The Capability Lens (and therefore the Offer Profiling Tool and Consumer Classification Model which it underpins) is based on 'best available opinion' (gathered via expert stakeholder workshops) rather than empirical evidence gathered from real world smart energy offers. To test its validity, we will create a programme of work in Phase Two to undertake a further review of empirical evidence, test its predictions of take up of specific types of offers and, potentially, undertake experimental trials to reveal the factors shaping the take up of offers.

### b. Improving the *Smart and Fair?* analytical tools

---

Beyond a beta version of the Offer Profiling Tool: Excel is not the ideal platform for the Offer Profiling Tool as it requires the correct version of Excel as well as existing knowledge of how to use this sort of spreadsheet tool. In Phase Two, we intend to

design a more intuitive, accessible web-based tool with a more refined ability to store and compare Offer Profiles, and also to allow users to contribute to a public store of Offer Profiles to build wider understanding of the smart energy market as it evolves.

**Improving the Consumer Classification Model:** Alongside the validation exercise outlined above, we would like to enhance the core dataset by incorporating data such as network constraint location and through further work to improve characterisation of a dwelling's suitability for certain technologies (like EV charging, solar PV or battery storage). Improved data on the relationship between household energy profiles and other household characteristics would also be useful (e.g. through better access to and analysis of smart meter data – see [www.smartenergypiag.org.uk](http://www.smartenergypiag.org.uk)). We will also seek to improve how mitigating interventions are characterised in the model (so that they can reflect better the real performance of such measures).

#### **c. Area profiling and offer and 'participation support' targeting**

---

As described in Section 5.1 above, we believe that the analytical framework we have developed can be used 'in reverse' to develop profiles of communities and neighbourhoods in terms of their likely interests in different types of smart energy offer and the sorts of interventions which might be necessary to secure inclusive participation. In Phase Two we would be keen to test this hypothesis in the first instance with one of the Prospering from the Energy Revolution projects, such as the SSEN-led Project LEO, and with specific communities with active energy groups looking to develop smart energy initiatives, such as those involved with WPD's Open LV innovation project.

#### **d. Designing and piloting interventions to increase and widen participation in smart energy offers**

---

To start to build an evidence base of which types of intervention are effective for which types of offer and which types of consumer, we need to be involved in designing, piloting and evaluating mitigation options alongside the roll-out of specific smart energy offers.

We envisage this might best be done at this early stage in partnership with DNOs/ DSOs as they undertake innovative projects involving domestic smart energy activities to support improved network management in particular localities. This could be linked to the area profiling mentioned above.

We can also anticipate working with specific smart energy offer providers to test different interventions to see which ones can best help to achieve more inclusive participation and at what cost.

#### **e. Market monitoring and support for implementation of the 'Guidelines'**

---

However useful our analysis to date might be, it has been largely theoretical because there are very few actual smart energy offers currently available in the domestic energy

market. As part of Phase Two, we are intending to develop (we anticipate in partnership with others), a significant programme of active market monitoring, engaging with those developing new offers and spotting and assessing smart energy offers as they come to market. Predictions derived from the Offer Profiling Tool and Consumer Classification Model will be able to be tested against actual market and consumer behaviour.

We can also provide support to those looking to follow the Guidelines outlined in Section 5.4 so that the required analysis and information can be provided. This will help to realise the benefits of the Guidelines being implemented routinely, including greatly enhancing the quality of market monitoring possible and the accuracy of the characterisation of offers in comparison websites.

#### **f. Distributional impact analysis**

---

As mentioned in Section 5.1 above, this analytical framework provides an opportunity in Phase Two to predict the likely distribution of participation in a smarter energy market. With some minor additions to the Consumer Classification Model and more robust data on the potential benefits and costs of participating in different smart energy offers, it will be able to predict the likely distribution of the financial benefits of the smarter energy market. This will reveal the likely 'winners' and 'losers' and the nature and scale of the 'wins' or 'losses' associated with different offers. Such analysis will enhance understanding of the impacts of the smarter energy market and also help to set priorities for action to mitigate impacts by improving and widening participation.

#### **g. Policy guidance, insight and advocacy**

---

We intend to use the insights gained in Phase One and those that will emerge from other elements of Phase Two to help inform better policy and regulatory design and implementation. Working with others seeking similar outcomes, this would include:

- The nature of consumer protection required in a smarter energy system.
- The interventions required to achieve wider and more inclusive participation and the policies and funding mechanisms needed to secure such interventions.
- The changing nature of consumer vulnerability as the energy system becomes smarter.
- How those vulnerable consumers least likely to participate in a smarter energy system might be protected from negative impacts they can ill afford.

We anticipate participating actively in the BEIS/Ofgem Smart Systems Forum, the ENA's Open Networks Project, and relevant Energy UK fora, and to provide responses to appropriate policy and strategic consultations from BEIS, Ofgem, the DNOs, Citizens Advice and others.

## Support us to deliver Phase Two of *Smart and Fair?*

If you would like to explore how your organisation could support and become involved with any of these elements of Phase Two of our *Smart and Fair?* programme, please contact:

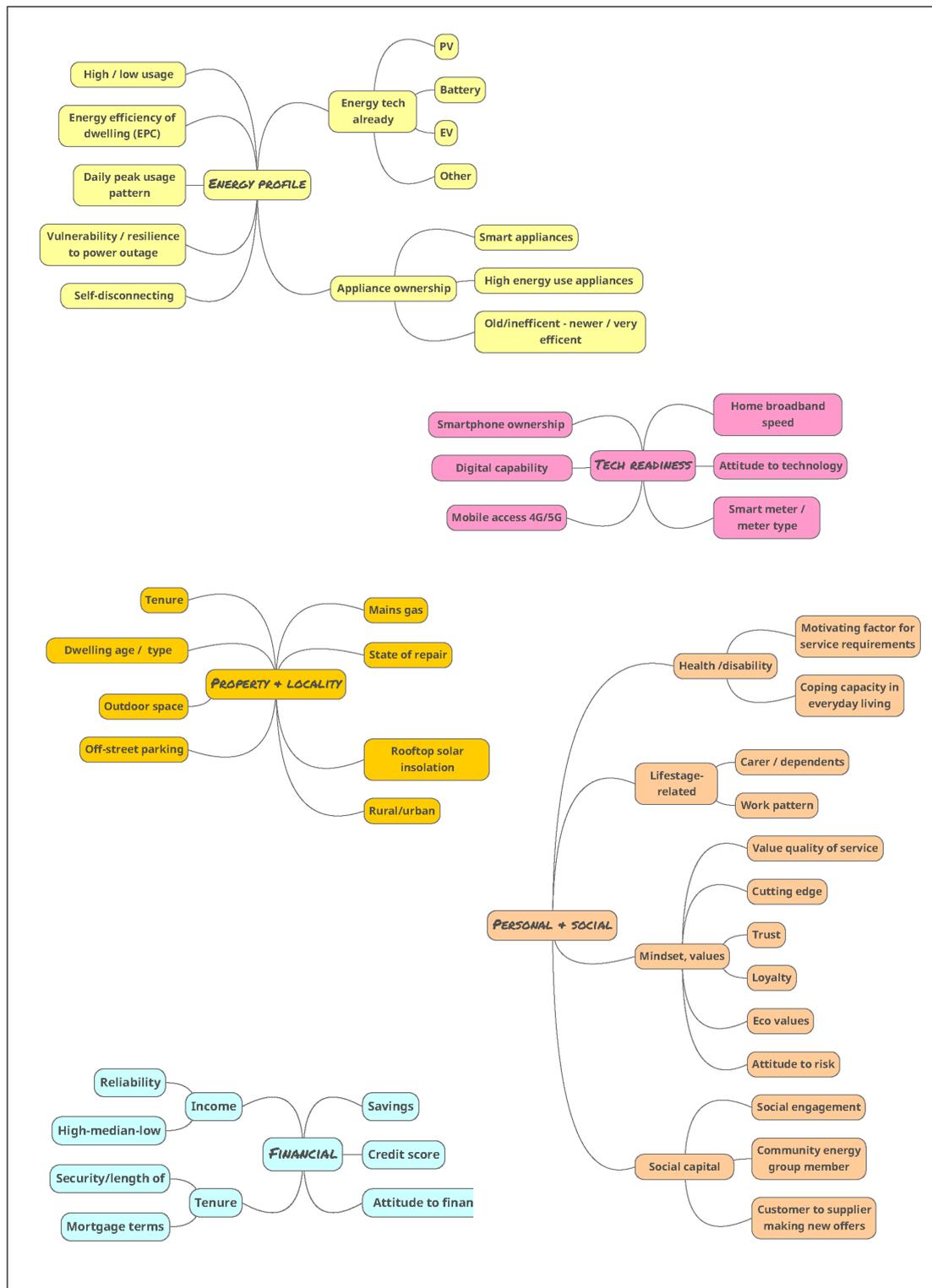
Simon Roberts OBE, CSE Chief Executive on [simon.roberts@cse.org.uk](mailto:simon.roberts@cse.org.uk)

Jenny Mitchell, CSE Senior Development Manager on [jennifer.mitchell@cse.org.uk](mailto:jennifer.mitchell@cse.org.uk)



# 6 Appendix

Figure 12: Prototype Capability Lens mind map, as used at first stakeholder workshop



**Table 9: Summary of the changes made to produce the beta version of the Capability Lens, based on feedback from the first stakeholder workshop testing the prototype model**

| Capability cluster in prototype | Revisions made in Beta model   | Reason   |
|---------------------------------|--|--|
| Energy profile                  | Renamed as 'Energy Tech and Usage'   | Clarify focus of cluster   |
| Energy profile – 'peak usage'   | Renamed as 'predictable, controllable, moveable peak usage' (suggest reword again as 'size and elasticity of peak usage'). | More precision regarding what is required of peak usage to be able to benefit from demand flexibility offers.  |
| Energy profile                  | Add heating technology.  | Several offers include use of heat technologies for energy storage or flexibility.   |
| Energy profile                  | 'Vulnerability/resilience' to power outage renamed as 'not vulnerable to power outage'.                                    | Consistency of focus on 'capability' to participate.   |
| Energy profile                  | 'Old / new appliances' removed.  | Duplicates 'usage pattern'.  |
| Property & locality             | Renamed as 'Dwelling and local area'.  | More accurate naming.  |
| Property and locality           | Addition of 'in area of network constraints' and 'indoor space for storage'.<br>Removal of 'tenure'.                       | Network constraints will encourage rewarding of consumers for flexing demand. Some offers will require new in-home technology to be installed. 'Tenure' also in financial cluster. |
| Financial                       | Addition of 'mortgage / leasehold rental terms/.   | Absence of restrictive terms will influence ability to participate in offers that require changes to property.   |
| Tech Readiness                  | 'Reliability of broadband' renamed as 'speed and reliability of broadband'.  | Additional capability dimensions pertinent to participation.   |
| Tech Readiness                  | Energy and dwelling specific technologies moved to other clusters.   | Strengthen cluster focus on relevant digital hardware, skills, knowledge and attitudinal requirements.   |
| Personal and social             | Simplification of cluster, but with addition of 'Readiness to engage in behavioural change'.                               | Certain factors may be relevant indicators but not of themselves essential requirements. Behavioural change seen as important to ability to benefit.                               |

## 6.1 References

- Arran, J. And Marshall Cross, R. (2019) How Accessible Are Future Energy Supply Business Models? A Report For Citizens Advice.
- Bankovskis, A. (2017) 'One Million Homes Constructed As &Quot; Buildings As Power Stations &Quot; – Synopsis Of Indicative Benefits', (August). Available at: [www.Specific.Eu.Com/Assets/Downloads/Executive\\_Summary\\_Of\\_Indicative\\_Benefits\\_Of\\_A\\_Million\\_Buildings\\_As\\_Power\\_Stations.pdf](http://www.Specific.Eu.Com/Assets/Downloads/Executive_Summary_Of_Indicative_Benefits_Of_A_Million_Buildings_As_Power_Stations.pdf).
- BEIS & Ofgem (2017) Upgrading our energy system - Smart systems and flexibility plan. Call for evidence question summaries and response from the Government and Ofgem. July 2017.
- Bristol Energy, Innovate UK and Regen (no date) Bristol Energy Smart System Transformation.
- Citizens Advice & ESC (2018) Smarter Protection Potential risks for consumers in a smart energy future: Closing report.
- Consumer Futures Unit (2016) Smart Move: Taking stock of the smart meter rollout programme in Scotland.
- Crisp, T. and Kruja, K. (2019) Future for all: making a future retail energy market work for everyone.
- Demski, C, Pidgeon, N., EVensen, D & Becker, S. (2019) Paying for energy transitions: public perspectives and acceptability. UKERC Policy Briefing.
- Edwards, C. (2019) 'Solent Achieving Value from Efficiency LCNF Tier 2 SDRC 4 Customer Model Final Report'.
- Elmustapha, H., Hoppe, T. and Bressers, H. (2018) 'Consumer renewable energy technology adoption decision-making; comparing models on perceived attributes and attitudinal constructs in the case of solar water heaters in Lebanon', *Journal of Cleaner Production*. Elsevier Ltd, 172(October), pp. 347–357. doi: 10.1016/j.jclepro.2017.10.131.
- ENA (2018) 'Open Networks Future Worlds', (July). Available at: [www.energynetworks.org/electricity/futures/open-networks-project/future-worlds/future-worlds-consultation.html](http://www.energynetworks.org/electricity/futures/open-networks-project/future-worlds/future-worlds-consultation.html).
- ENA (2019) 'Energy Networks Association Open Networks Project Future Worlds Impact Assessment 2019 Workplan Webinar', p. 27. Available at: [www.energynetworks.org/assets/files/Open\\_Networks\\_Workplan\\_2019\\_Webinar-v3.pdf](http://www.energynetworks.org/assets/files/Open_Networks_Workplan_2019_Webinar-v3.pdf).
- Energy Systems Catapult (2019) 'Energy Systems Catapult Digital Landscape'.
- ETI /ESC (2015) Living Carbon Free: Exploring what a net-zero target means for households.
- ETI /ESC (2019) Pathways to Low Carbon Heating: Dynamic Modelling of Five UK Homes.
- Financial Conduct Authority (2017) 'Understanding the financial lives of UK adults Findings from the FCA's Financial Lives Survey 2017', *Financial Lives Survey*, (October). Available at: [www.fca.org.uk/publication/research/financial-lives-survey-2017.pdf](http://www.fca.org.uk/publication/research/financial-lives-survey-2017.pdf).
- Gregg, J. S. et al. (2020) 'Collective action and social innovation in the energy sector: A mobilization model perspective', *Energies*, 13(3). doi: 10.3390/en13030651.
- Hardy, J. (2017) 'How could we buy energy in the smart future?', (March), p. 8. Available at: [www.smartenergygb.org/en/~media/SmartEnergy/essential-documents/press-resources/Documents/How-could-we-buy-energy-in-the-future-by-Dr-Jeffery-Hardy.ashx](http://www.smartenergygb.org/en/~media/SmartEnergy/essential-documents/press-resources/Documents/How-could-we-buy-energy-in-the-future-by-Dr-Jeffery-Hardy.ashx).
- Hubert, M. et al. (2019) 'The influence of acceptance and adoption drivers on smart home usage', *European Journal of Marketing*, 53(6), pp. 1073–1098. doi: 10.1108/EJM-12-2016-0794.
- Lloyds Bank (2019) 'UK Consumer Digital Index 2019', p. 56. Available at: [www.lloydsbank.com/assets/media/pdfs/banking\\_with\\_us/whats-happening/LB-Consumer-Digital-Index-2018-Report.pdf](http://www.lloydsbank.com/assets/media/pdfs/banking_with_us/whats-happening/LB-Consumer-Digital-Index-2018-Report.pdf).
- MHCLG (2018) English Housing Survey Energy Report 2017 - 18, Communities. doi: 10.1017/CBO9781107415324.004.

- Michie, S., van Stralen, M. M. and West, R. (2011) 'The behaviour change wheel: A new method for characterising and designing behaviour change interventions', *Implementation Science*, 6(1), p. 42. doi: 10.1186/1748-5908-6-42.
- Moretti, M., Djomo, S, Azadi, H., May, K. & De Vos, K. (2016) A systematic review of environmental and economic impacts of smart grids. <https://doi.org/10.1016/J.RSER.2016.03.039>
- National Grid (2019) Future Energy Scenarios, Future Energy Scenarios.
- Nicolson, M. L., Fell, M. J. and Huebner, G. M. (2018) 'Consumer demand for time of use electricity tariffs: A systematized review of the empirical evidence', *Renewable and Sustainable Energy Reviews*. Elsevier Ltd, 97(August), pp. 276–289. doi: 10.1016/j.rser.2018.08.040.
- Ofcom (2020) The Communications Market Report - interactive data portal. [www.ofcom.org.uk/research-and-data/multi-sector-research/cmr](http://www.ofcom.org.uk/research-and-data/multi-sector-research/cmr)
- Office of National Statistics (2020) 'Social capital in the UK : 2020', pp. 1–13.
- Roberts, S. (2018) 'Making 'No one left behind' meaningful in our future energy system', essay for Citizens Advice published in 'A Price Control for Everyone', December 2018. Available at [www.cse.org.uk/news/view/2281](http://www.cse.org.uk/news/view/2281)
- Shakoor, A. et al. (2017) 'Roadmap for Flexibility Services to 2030: A report to the Committee on Climate Change', (May), p. 92. Available at: [www.theccc.org.uk/wp-content/uploads/2017/06/Roadmap-for-flexibility-services-to-2030-Poyry-and-Imperial-College-London.pdf](http://www.theccc.org.uk/wp-content/uploads/2017/06/Roadmap-for-flexibility-services-to-2030-Poyry-and-Imperial-College-London.pdf).
- Snell, C., Bevan, M. and Thomson, H. (2014) Fuel Poverty and disabled people: the impact of policy change, (Research report for EAGA charitable trust). Available at: [www.eagacharitabletrust.org/app/uploads/2016/03/yorkuniresearchsummary.pdf](http://www.eagacharitabletrust.org/app/uploads/2016/03/yorkuniresearchsummary.pdf).
- Sovacool, B. K., Lipson, M. M. and Chard, R. (2019) 'Temporality, vulnerability, and energy justice in household low carbon innovations', *Energy Policy*, 128, pp. 495–504. doi: 10.1016/j.enpol.2019.01.010.
- SRHIE (2010) Fair-Society-Healthy-Lives-Full-Marmot Report, Strategic Review of health inequalities in England. doi: 10.1016/j.puhe.2012.05.014.
- SSE (2017) Supporting a Smarter Electricity System.
- UKERC (2019) Disrupting the UK energy system : causes , impacts and policy implications.
- UKPN (2019) Energy Wise: The final energy saving trial report. Available at: <http://search.ebscohost.com.proxy.seattleu.edu/login.aspx?direct=true&db=a9h&AN=89570875&site=ehost-live&scope=site>.

## Support us to deliver Phase Two of *Smart and Fair?*

If you would like to explore how your organisation could support and become involved with Phase Two of our *Smart and Fair?* programme, please contact:

Simon Roberts OBE, CSE Chief Executive  
[simon.roberts@cse.org.uk](mailto:simon.roberts@cse.org.uk)

Jenny Mitchell, CSE Senior Development Manager  
[jennifer.mitchell@cse.org.uk](mailto:jennifer.mitchell@cse.org.uk)

---



centre for  
sustainable  
energy

St James Court  
St James Parade  
Bristol BS1 3LH

0117 934 1400

[info@cse.org.uk](mailto:info@cse.org.uk)

[www.cse.org.uk](http://www.cse.org.uk)

twitter: @cse\_bristol

youtube: csebristol

Company 2219673  
Charity 298740