How can innovation deliver a smart energy system that works for low income and vulnerable consumers?

Project InvoLVe

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How can innovation deliver a smart energy system that works for LIV consumers?

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Introduction

This review focuses on how innovation could enable low income and vulnerable (LIV) consumers to participate in a smart, flexible energy market. There are several drivers for this work. Government, Ofgem and industry are keen to maximise the potential for all consumers to take part in smart energy technologies, smart tariffs and services. Changes to the energy system and domestic market raise concerns about whether low income and vulnerable consumers could be less willing and less able to access, purchase and use smart energy products and services.

This review summarises evidence to answer the following questions:

1. How do low-income and vulnerable consumers participate in a smart energy market? What barriers prevent their participation?
2. Does existing innovation activity help them engage in this market?
3. How will new innovation activity ensure they are engaged in this market?
4. How could innovation put them at the forefront of the smart energy transition?
5. What risks could emerge when, and how could innovation prevent them?
6. Where should future innovation focus?

Key findings

The findings revealed **a limited amount of evidence about how LIV consumers could participate in smart energy products and services of the future**. The evidence reviewed showed the majority of existing innovation projects on LIV consumers have focused on accessing and using products and less on how these consumers could purchase or pay for them.

Projects typically try to persuade LIV consumers to trial existing technologies rather than finding out what consumers want and designing technologies they find appealing and useful. Whilst some LIV consumers did participate in these projects, the reason that LIV consumers did not want to participate was they did not think the technology fitted into their everyday routines and the way they wanted to live in their home. This report focuses on the experience of LIV consumers. It is possible that some conclusions are relevant to a range of consumers but conclusions relevant to LIV consumers were the focus of this report

Each project developed their own way of working with LIV consumers, including recruiting participants, developing consumer protections and communicating about using in-

home devices. The project teams' experience delivering projects changed their views on how best to work with LIV consumers. However, each project had to learn these lessons from scratch, rather than building on others' experiences.

Of the energy innovation projects with LIV consumers reviewed, most did not follow all the steps in what some consider best practice innovation processes used in other sectors. This involves working with consumers to understand the problem space (discovery), co-creating solutions with them (alpha) and trialling at increasing scale (beta), before going live. Future innovation would maximise its potential by taking a human-centred design approach. This would design products and services that addressed consumers' needs and solved their problems.

Expert stakeholders proposed **a wide range of factors that could be obstacles for LIV consumers** participating in the future but very few of these obstacles have been explicitly investigated in existing innovation projects. Some obstacles could affect people's ability to participate, and others could affect their willingness to participate. Recent innovation projects have sought to ensure LIV consumers participate in innovation projects by removing the obstacles completely. This does not demonstrate how the obstacles could be overcome in a future smart energy market. For instance, innovation that provides technology free of charge or only works with households that already have that technology do not learn how to overcome obstacles LIV consumers have in purchasing smart energy products and services in the future.

The review identified 6 **risks that could emerge as a smart energy market develops**:

1. LIV consumers may not be able to afford to purchase smart products and services
2. LIV consumers may not benefit from smart products and services
3. LIV consumers face greater risks if the product or service fails to work as expected
4. Lack of data access reduces how much LIV consumers benefit
5. Unequal distribution of system costs
6. LIV consumers experience problems that may impede the emergence of a smart energy market

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Recommendations

As a result of this review, there are 6 key recommendations for future innovation to enable LIV consumers to participate in a future smart energy market. Figure 1 illustrates how these recommendations can enable ideas to become products and services that LIV consumers can use in a smart energy market.

There are two main principles that would have a long-term impact on all future innovation projects which involve LIV consumers :

1. Encourage relevant innovation projects to follow best practice, human-centred innovation processes

2. Create a publicly funded innovation ecosystem that supports LIV consumers

There is one recommendation to build a comprehensive discovery evidence base to discover what LIV consumers need from energy and the problems they may face to focus smart energy innovation on meeting their needs and solving their problems:

3. Commission a comprehensive and practical discovery evidence base

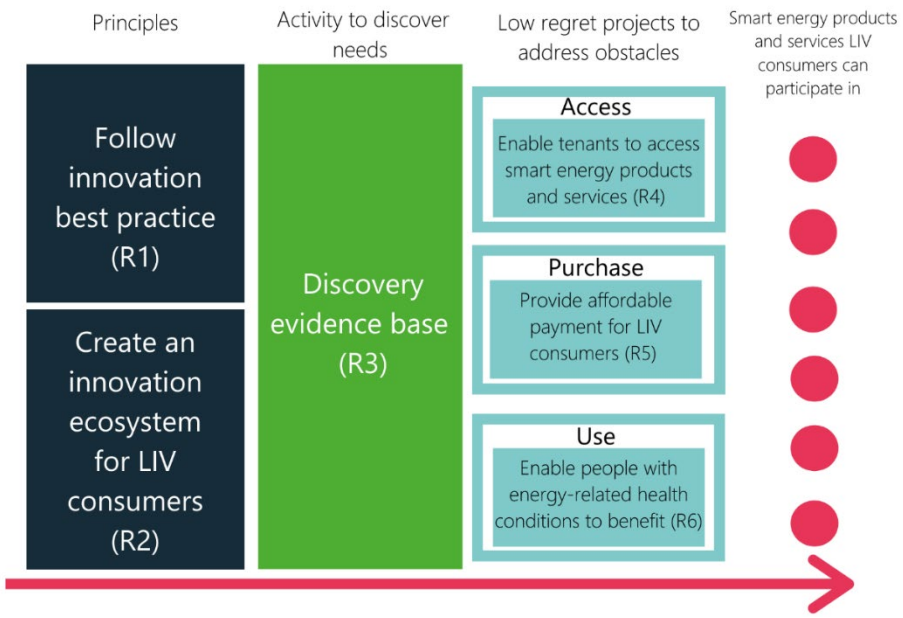
There are three low-regret recommended projects that would address obstacles, allowing LIV consumers to access, purchase and use smart energy products and services:

4. Enable tenants to access smart energy products and services

5. Provide affordable payment options for LIV consumers

6. Enable people with energy-related health conditions to benefit from smart energy products and services

Figure 1. Diagram of main InvoLVe recommendations



1. Introduction

1.1 Rationale for the research

The UK's Net Zero target will drive radical changes to the energy system between 2020 and 2050. A smarter, more flexible energy system will be required and could help create savings for consumers and the wider electricity market. Government, Ofgem and industry are pursuing this in a range of ways, whilst maximising the potential for all consumers to participate in this smart, flexible energy market of the future[1]. This could result in new technologies and appliances in consumers' homes, access to smarter tariffs, interaction with a broader range of service providers and new infrastructure in their local area. Specifically, this could include smart metering, demand side flexibility, electric vehicles, electric heat pumps and domestic energy storage.

These changes to the energy system raise a core concern about whether low income and vulnerable consumers will be able to participate in this future. There are risks and opportunities in this.

Low income consumers are less likely to be able to afford the upfront capital cost of smart technologies that could give them access to smart tariffs and services. Without access to these, there is a risk that they will be excluded from lower costs for energy consumption. Consumers in vulnerable circumstances may have additional needs from energy, such as higher indoor temperatures or electricity for health-related appliances. Both low income and vulnerable consumers could be less able to access and use smart products and services because of additional obstacles to them. This could include that they don't have permission to make changes to their home or they can't change their current energy supplier because of debt. Obstacles could also exist because products and services are not accessible to them, such as they have low digital skills or physical disabilities that technologies are not designed for. Low income and vulnerable (LIV) consumers may not be able to participate and/or may not be willing to participate. Both ability and willingness need to be addressed in order to see LIV consumers are not excluded.

There are also opportunities that LIV consumers could be better served by smart energy products and services than they are currently. Low income consumers could have access to new technologies and products that could improve their living environment. Consumers struggling to control how much they spend on energy to get comfortable could use new devices and services that allow them to choose different options of what they spend and when. Consumers with specific health needs from energy could see more personalised tariffs and services to meet their needs. LIV consumers that were previously considered to be high cost to serve by suppliers could provide valuable flexibility to the electricity grid.

[1] See 2017 Smart Systems & Flexibility Plan: https://www.gov.uk/government/publications/upgrading-our-energy-system-smart-systems-and-flexibility-plan

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Innovation across the energy system is already transforming the sector, with many innovation projects over the last decade (e.g. projects funded from a range of programmes including the Low Carbon Networks Fund, Network Innovation Allowance, Network Innovation Competition). Some have involved low income and vulnerable consumers but there were relatively few which focussed specifically on LIV consumers and there is a risk that LIV consumers are less likely to be early adopters of innovative new products and services. LIV consumers may be less likely to leave their current supplier to try out something new (Ofgem, 2020). They may face barriers to switching (for example, they do not use the internet) or need support (e.g. repaying energy debt).

With the introduction of many new technologies and services into consumers' lives, it is important to ensure they are able and willing to participate in a smart energy market in a way that enhances their lives rather than introduces new challenges to get the essential service of energy.

1.2 Relevant terms

Smart energy markets use data and IT to integrate actions of users and operate technology. Our focus is where it is part of management and use of household energy consumption. It is currently in its infancy but has the potential to become very important in future.

Consumer participation refers to access, purchase and use of smart energy products and services.

Low income refers to consumers who cannot afford their energy bills or the equipment they need to participate in a smart energy market and benefit from smart tariffs. It was not necessary to use a threshold-based definition of low income as the term was used in a comparable way across the recent innovation activity and in discussions of the future. Currently those living on a low income pay more proportionally for their energy than those living on a higher income.

Vulnerable circumstances exist when a person interacts with a system. Someone is not intrinsically in vulnerable circumstances, for instance if they have low digital skills. Instead they are in vulnerable circumstances if they need medium to high digital skills to interact with a system they need to use. We found studies and experts used the term vulnerability to mean different things.

It is possible to be both living on a low income and living in vulnerable circumstances, they are not mutually exclusive. Low income or vulnerable consumers may not be able to afford their energy bills, participate in a smart energy market or benefit from smart tariffs and technologies.

Innovation refers to creation of a new offering (i.e. tariff, technology, business model or a combination) that appeals to consumers, is commercially viable and technically feasible (Figure 2) (Innovate UK , 2020; IDEO). To be commercially viable an offer must cost less to deliver than consumers can afford to pay for it. The standard process involves identifying problems that matter and moving through them to deliver solutions. Innovators do this by

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identifying consumers' needs, testing and then iterating prototype solutions, before scaling up what works well.

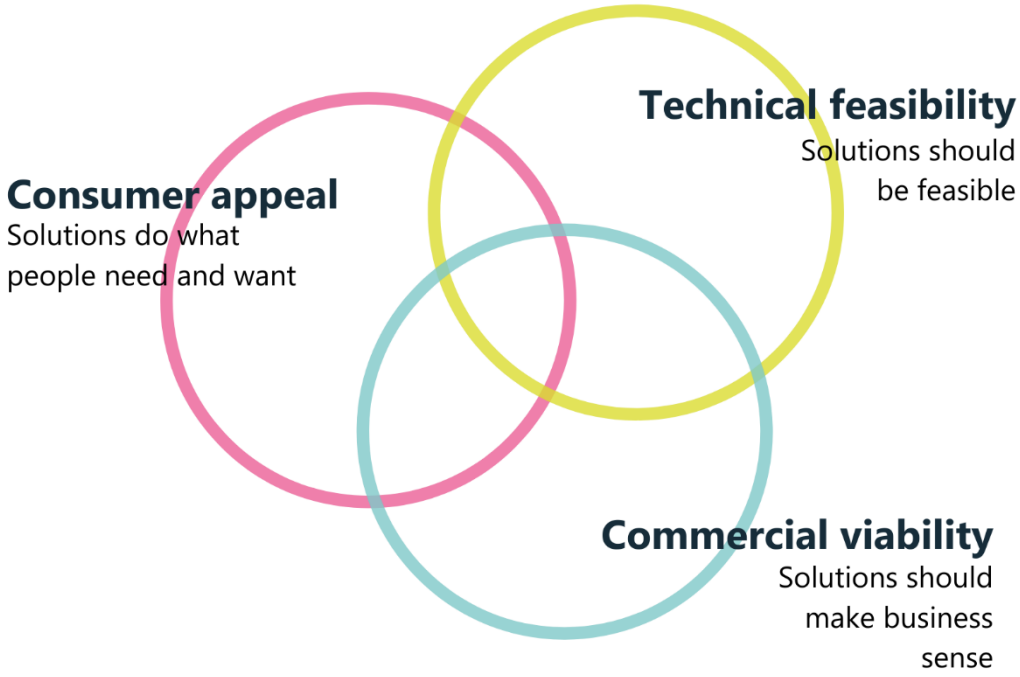

Figure 2. Three lenses of innovation. Adapted from UKRI (2020) Design in innovation strategy.

1.3 The focus of this study

This study was designed to answer the following research questions:

1. How do low-income and vulnerable consumers participate in a smart energy market? What barriers prevent their participation?

This research question investigates the domestic and international evidence of how LIV consumers may access, purchase and use smart energy products and services as well as the obstacles that may stop them being able to do that.

2. Does existing innovation activity help them engage in this market?

This research question focuses on understanding whether the innovation activity that has taken place has enabled LIV consumers to participate in a smart energy market, not just the innovation activity (such as 12-month projects) itself.

3. How will new innovation activity ensure they are engaged in this market?

This research question explores what opportunities future innovation activity has to include LIV consumers and ensure they can participate through the design of the activity. It describes examples of inclusive and universal design in other consumer markets.

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4. How could innovation put them at the forefront of the smart energy transition?

This research question describes the opportunities for different products and services to be accessed, purchased and used by LIV consumers to improve their lives in the future and the features that might be needed in the market to see that happen.

5. What risks could emerge when, and how could innovation prevent them?

This research question focuses on the risks that could emerge as a smart energy market develops, the timing and context of these risks and how innovation activity could mitigate them.

6. Where should future innovation focus?

This research question explores how future innovation activity could be focused to ensure LIV consumers can access, purchase and use smart energy products and services.

2. Methodology

The study involved two parts: an evidence review of available literature and interviews with 25 key stakeholders. The relationship and timing between the two parts is shown in Figure 3.

Figure 3. Steps of the methodology used

Evidence search

The evidence search involved an initial methodical desk-based search against a set of criteria and key terms. It focused largely on evidence that was available online, in English and discussed activity within the last 10 years. The search used academic databases, innovation funding competition records and relevant research and consultancy websites. Evidence was collected and organised through a rapid review, which allowed us to draw out any relevant innovation project and exclude any evidence that wasn't relevant on further investigation. A second evidence search was conducted after the stakeholder interviews had taken place.

Stakeholder interviews

We conducted semi-structured interviews with 25 organisations, sometimes with more than 1 representative present, focused on identifying current innovation activities and understanding future needs and obstacles to innovation. These interviews were transcribed and analysed across the different areas of the 6 research questions.

Stakeholders were engaged during the evidence search so that they could recommend evidence to include in the review, improving the breadth of evidence included. An initial long list of potential interviewees was created from those frequently cited in relevant evidence, those well-known in the field of LIV energy consumers and referrals through relevant contacts. A diversity of organisation types and consumer groups were represented in the final 25 interviews including academia, research consultancy, commercial retailers, consumer advocacy, network operation and energy supply. Each stakeholder was positioned within one of the four stages of the innovation process (Figure 4, p9) to ensure we had representatives working in different areas of innovation.

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Evidence review

We wanted to focus the majority of the analysis on projects that had done innovation with LIV consumers rather than those that were about possibilities and hypothetical scenarios of the future. We therefore divided the evidence into two categories:

- Evidence that discussed projects doing innovation (referred to as 'projects' from here)
- Evidence 'about' innovation i.e. based on expert opinion rather than experience of doing innovation in a project with LIV consumers.

The full list of evidence that was reviewed is given in the bibliography at the end of this report.

The criteria for projects included in this review

1. They were innovation projects. As per the above definition, their objective must be to create a new tariff, technology or business model through the activity. This could mean that they have acknowledged, explicitly or implicitly, that they are following the innovation process, or their activity is part of the process. For example, they may just be considering alpha phase activities, having built on other activity that conducted discovery phase activities.

AND

2. They focused on smart energy products and services.

AND

3. They must explicitly include LIV consumers as the imagined end user if consumers aren't involved in the activity or must involve LIV consumers as the majority of the consumers involved in the activity. This could mean an explicit objective to deliver a solution that works for consumers that include those that may be LIV or the solution was developed and trialled with LIV consumers.

By focusing the majority of the analysis on projects that had done innovation with LIV consumers we were able to gather insights relevant to how future innovation could realistically happen in the real world. Where there is no or little real world innovation available to answer a certain research question, we have drawn on the evidence about innovation by experts. Many of these experts and the organisations have experience of working with LIV consumers that they undoubtedly would have drawn on to imagine the future possibilities discussed in their work.

The strengths and limitations of this methodology

There are significant strengths to using this combined methodology to explore the research questions.

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Given how early in the transition we are and the little activity seen with LIV consumers to date, there was a risk that an evidence review alone could produce only a small amount of evidence of energy innovation activity. However, with the expansion of the interviewees to include those from other sectors, we were able to draw on how innovation activity elsewhere has allowed LIV consumers to participate. Finance has been going through a digital transition for some years and the housing sector has used innovation to tackle problems across many different parts of its business.

A desk-based evidence review allows international evidence to be gathered at a low cost and short amount of time whilst providing new perspectives that might not be discussed by those within the UK energy sector. Evidence from a wide range of sources can be included and shaped as the evidence review is happening, rather than from a pre-determined set of sources. The combination of the evidence review and interviews allowed us access to the most up-to-date information and documents. Some of our evidence was only released during the time of the evidence review and interviewees gave us sight of what else might be coming out soon. Reviewing documents and reporting generates in-depth knowledge about each project and study as well as the opportunity to be referred to identify and review other relevant work quickly and at low cost.

The approach was a rapid evidence assessment, rather than a systematic review (Collins et al, 2015; Robinson and Lowe, 2015). It searched specific databases and grey literature using search terms to answer specific questions; included fewer than 50 papers; and proposed actions based on the evidence found. The method had some limitations. It relied on published reports, rather than unpublished commercial work (though we found few businesses were innovating with LIV consumers). There were gaps in the reports that made it hard to compare projects and answer all the research questions conclusively. Most notably, reports and interviewees appeared to use different definitions for low income and vulnerable consumers and reported on outcomes differently, which made it hard to compare across projects.

3. Recent innovation activity for low income and vulnerable consumers

Key insights

- The findings revealed a limited amount of evidence about how LIV consumers could participate in the future smart energy market. The majority of existing innovation activity has focused on LIV consumers accessing and using products and less on how these consumers could purchase or pay for them.
- Projects typically try to persuade LIV consumers to trial existing technologies rather than finding out what consumers want and designing technologies they find appealing and useful.
- Of the energy innovation projects with LIV consumers reviewed, most did not follow the best practice innovation process used in other sectors. This involves working with consumers to understand the problem space (discovery), co-creating solutions with them (alpha) and trialling at increasing scale (beta), before going live.
- LIV consumers involved in existing projects lived in a range of vulnerable circumstances and on low incomes, including those living with a physical disability, unemployed or renting their home from a social housing provider. Projects did not report data on the mix of LIV participants that could be used to produce a picture of how different consumers responded to different smart products and services.
- Each project developed their own way of working with LIV consumers, for example developing consumer protections. The project teams' experience delivering projects changed their views on how best to work with LIV consumers. However, each project had to learn these lessons from scratch, rather than building on others' experiences.
- The obstacles preventing people from participating in a future smart energy market will be different to those than the current energy market. Some obstacles will affect people's ability to participate and others will affect their willingness to participate.
- Experts have views of what a 'fair' energy system might look like and what the potential obstacles are for LIV consumers. However, the innovation projects analysed within this report rarely focussed on delivering this 'fair' energy system in practice or establish what obstacles LIV consumers experience.

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3.1 Introduction

This chapter considers projects and relevant evidence about recent innovation activity from an evidence review and 25 expert stakeholder interviews. It examines how innovation activity has identified problems and delivered solutions that could affect how LIV can participate in a smart energy market in future. It answers the following research questions:

1. How do low-income and vulnerable consumers participate in a smart energy market? What barriers prevent their participation?

2. Does existing innovation activity help them engage in this market?

3.2 Recent innovation activity for low income and vulnerable consumers

Innovation is the process of creating a new offer. The standard innovation process when designing something that involves humans using the products and services being created is shown in Figure 4.

Figure 4. Phases of innovation. Adapted from the Government Digital Service (GDS)

This process involves discovering what the problem is, then designing a prototype solution and gradually testing it with users to refine it until it works well. The aim is to understand what works well before launching and scaling in the real world. You need a discovery phase to find out the problem innovation is aiming to solve and consumer feedback to iterate or improve the solution.

Boundaries of the innovation activity considered

This section considers innovation activity that we identified through the evidence review and stakeholder interviews. At this stage, market uptake of smart energy products and services is low, so in this report we are focused on the process that could see the necessary increase in market uptake, rather than the specific outcome for a smart energy market. This means that we are discussing activity ‘doing innovation’ (referred to as ‘projects’ from now on), rather than ‘about’ the potential outcomes of innovation, such as fairness of a smart energy market.

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Selected projects for in-depth review

Name of project	Innovation phase	Smart product or service	Imagined end users	Consumers involved	Timing of activity	Funding source	Geographical location
Do smart heating controls help vulnerable consumers	Discovery, alpha, beta	Smart heating controls and smart energy services	Fuel poor households	Fuel poor households	November 2019 – March 2020	Energy Revolution Integration Service/Innovate UK	England
Energywise	Discovery, beta	Smart technologies and Time of use tariffs	Households in an area of deprivation, living in social housing	Households in an area of deprivation, living in social housing	January 2014 - September 2018	Network innovation competition	England
Equal Electric	Discovery	Electric vehicles	N/A	Motorists with disabilities	Oct 2020 ongoing	Network innovation allowance	UK
PowerShift	Beta	Flexibility, smart energy management	Low income households	Low income households	2016 to 2019	National government	Australia
Optimised Retrofit	Discovery, beta, live	Smart energy management, smart heating and energy technologies	Those living in social housing	Residents living in social housing on a low income	Dec 2020 ongoing	National government	Wales

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Name of project	Innovation phase	Smart product or service	Imagined end users	Consumers involved	Timing of activity	Funding source	Geographical location
Healthy Ageing Trailblazers Project Maslow	Discovery	Smart home technologies	Older households wanting to live independently	Older households wanting to live independently	Nov 2020	Innovate UK	England
Pioneering Policy Making	Discovery, alpha	Smart energy tariffs	Low income and vulnerable households	Low income and vulnerable households	2018-2019	National government	UK
Urban Energy Club	Discovery, alpha, beta	Flexibility	Those living in flats rented through a social housing provider	Those living in flats rented through a social housing provider	March 2019 – Nov 2020	National innovation allowance	UK

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Key themes and insights from recent activity

Firstly, insights relevant to phases of innovation are identified, followed by key general themes across the projects. These insights are drawn from the projects doing innovation and relevant evidence about future possibilities of innovation.

Discovery

- Few projects planned discovery phases to understand consumer needs before designing the solution.
- Some projects changed how they designed and developed the product or service based on consumer responses but this often appeared unplanned and not part of the original methodology.
- The small minority of projects that did discovery phases found their initial assumptions of what consumers would want were challenged. For instance, participant's interest in engaging with their energy consumption was lower than was assumed.
- The minority of projects that included discovery phases were usually very narrowly focused. For instance, they assumed that a specific obstacle prevented LIV consumers from participating in smart energy, then studied this obstacle. This narrow focus means they may have missed other, potentially more important, issues.
- Project example: Project Maslow did discovery phases because they didn't know what the consumer problem to solve was and wanted to understand this before designing a solution.

Alpha

- Most projects didn't explicitly include an Alpha phase. This means they did not design and test ideas with consumers against hypothesis they had before deciding what the technical solution was.
- Project example: The Ofgem and BEIS Pioneering Policy project specifically mentioned testing ideas with consumers and designing the solution with them. However, this project was focused on switching to different tariffs in the future, not smart products or services.
- Projects rarely tested ideas, so they did not stop ideas that failed or tackle issues quickly and cheaply before testing them at a bigger scale.

Beta

- Projects that were completed often discovered new consumer needs during the beta phases of projects, i.e. when solutions were being refined in real world environments. Where this happened, the result of this was that some consumers were not able to take part or didn't feel the solution was something they were interested in.
- Project example: one of the lessons learnt in Energywise was to incorporate learnings from early phases of the activity into what happened in later phases in order to get long term engagement from householders.

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- The views of consumers on the ease of use of the product or service differed from the expert view or the organisations conducting the project. In a number of cases consumers reported devices harder to use than the experts felt they were.

Live

- Time of Use tariffs were the focus of projects doing large scale demonstrations. This live phase had followed an alpha phase testing different tariff designs in the real world.

There were also insights about the way the projects were designed. The projects were funded from different organisations and different funding streams. The initial criteria for the funding shaped what the activity was trying to achieve and how it was carried out. For instance, UK projects funded through the National Innovation Allowance must state the starting and finishing Technology Readiness Level (TRL) in the initial registration document. This meant projects were predominately designed around technical innovation and not commercial viability or consumer appeal. Some NIA projects had discovery phases, but this phase did not improve the design of the solution. For example, the Energywise project did not apply lessons they learnt in discovery to re-design the solution they trialled. This project concluded they could have improved the experience of consumers in their trials and reduced the number who chose to leave the project if they had changed their solution based on what they learnt in discovery. In another example, the Healthy Ageing Trailblazer funding was a competition aimed at any products, services or business models that supported people to age well. Project Maslow, of this fund, focused not on a specific technology but on identifying the correct problem to be solved so that people could achieve an outcome, in this project this was to live independently in their current home.

Innovation in other sectors often aims to improve products or services, not just reduce their cost. For instance, when transport went from horse to car and heating from coal fires to central heating, the new solutions offered consumers clear benefits (Foucquet, 2010). However, funding in the energy sector often aims to save money for consumers without any discovery process to confirm that this is what matters most to LIV consumers. Consumers wanted cars and central heating because they were better and improved their lives, not cheaper to run. It may be important that innovation funding aims to improve energy solutions and consumer experiences, not just reduce costs, if the energy industry is to go through a radical change.

The everyday routines and lives of consumers played a significant role in whether people wanted to participate in innovation activity, whether they used the product or service as it was designed and whether people saw benefit from being active participants if required. They chose not to take part if they could not see how a solution would fit into their routine or help them do the things they wanted to do. Sometimes the solution could address problems they had but in one project, the solution was framed in terms of the technical details of the tariff rather than how it could help them with their household routines. This was found to reduce people's willingness to take part (Johnson, 2020). Sometimes the solution had been designed to provide system benefits and consumers couldn't identify how that system benefit was something they valued or were interested in.

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> *I think that these conversations [about what innovation activity should happen] should start with the people, and trying as best as possible to identify what problems people have and how they understand it, and see if you can build something out of the existing architecture that we have that can try to potentially solve that problem that people have.*
>
> *InvoLVe interviewee*

Complete and ongoing projects have included activity where industry stakeholders identify the challenges that consumers will face in the early phases of the project. Previous projects have found that the challenges that consumers will face engaging with a particular activity or solution were underestimated – with more barriers to them being able to access the solution in the first place and the barriers that were expected excluding more people than were anticipated at the start of the project. This led to a smaller pool of potential participants and higher drop out rates as the activity progressed.

The technical design of the solution was one of the main reasons why people didn't want to or weren't able to take part. In some cases, the technical solution could not accommodate less usual payment types (e.g. prepayment and cheque in Urban Energy Club) even though these are likely to be more common in the imagined end user group of the project (LIV consumers) than the national population. In other cases, people were excluded by design, such as people that didn't yet have a smart meter or didn't want one could not take part in the innovation activity because the solution relied on a smart meter being present. In other cases, people were able and willing to take part but didn't like the device put in the home whilst they were participating so would remove them. People removed temperature monitors from their bedroom because it was deemed to be too intrusive and unplugged the power source of equipment. In the Energywise project this resulted in significant data loss, which amongst other things, was part of a protocol for managing the risk of low indoor temperatures to householders.

> *It should feel like progress, it should be better, it should feel easier, it should be a positive step forward for people rather than getting people to have to live in a certain way, or use things in a certain way, or force behaviours. So the perfect outcome is having people live like they always have, go about their day in the normal way without expecting them to do anything widely different.*
>
> *Involve interviewee*

Each project develops its own way of working from scratch. This includes recruiting participants, installing monitoring equipment (which is often removed at the end) and gathering consumer feedback. Each project has to allocate resource learning how to do this and it leads to a range of different approaches which can be hard to compare.

Where details of the method were available, each project appeared to use its own recruitment methods and materials. Each project appeared to decide on which consumers to include or excluded based on their initial assumptions about the consumers they might see trying to participate. Learnings from previous or other projects weren't mentioned as included in this

process. The partial exception to this was in Energywise where the local community centre partner in the project did an initial categorisation of the risks for each household wanting to participate. Energywise also published a large amount of detail on the learnings from the project compared to other projects.

The high-level categories of consumers that projects were aiming to work with (e.g. people living in social housing or older people wanting to live independently) was available within this review. More detailed data or other consumer data (e.g. other vulnerabilities, their interest in new technology, their current energy demand) didn't appear in the evidence that we reviewed. Outcomes of the smart products and services for different consumers also wasn't available. The lack of this information means results could not be compared across projects to understand which consumers were able to participate in which products and services.

3.3 How innovation projects have helped low income and vulnerable consumers participate in a smart energy market

Participating in a smart energy market means consumers being able to access, purchase and use smart energy products and services. Innovation activity that involves LIV consumers' needs to help us understand how these consumers can participate in a real market, not just participate in an innovation project. Innovation projects are the way to get products and services that will make up the real market. This analysis draws on what innovation projects did and how it helped to ensure innovation projects lead to participation in a future smart energy market.

Access

Projects that have involved using new devices in people's homes have demonstrated new practical issues around installation of new devices and the need for pre-existing technologies (for example, smart meters). Issues around installation and the need for some pre-existing technologies in people's homes is likely to continue to be a challenge for people to access products and services in a smart energy market and is not one easily solved as UK homes vary substantially in their condition.

The organisations involved in designing and delivering the activity have played a substantial part in which consumers can participate in the innovation. Social housing tenants have been able to access innovative products and services because their social housing provider opted them in. Energywise, Urban Energy Club and Optimised Retrofit worked with social housing providers to innovate with their residents. Urban Energy Club didn't include recruitment in its project activity and funding but worked with residents from an existing community project. In Equal Electric, an existing relevant consumer group was used to connect to disabled motorists. Other projects appeared to recruit new participants from the general population. There is no comparable evidence to show the effect of different organisations on participation.

Where social housing providers have been used, it appears to have overcome the barrier of individual householders trying to gain permission to add new technology, products and services from their landlord. In a smart energy market, this same model could be viable, as improvements to homes owned by social housing providers are usually agreed on groups of homes and have in the past provided innovative smart energy products and services to these consumers (e.g. the projects Energywise and Optimised Retrofit).

Projects initially excluded people from participating that they deemed to be 'too vulnerable'. However, organisations found they could mitigate the risks more easily than they had expected during delivery of the project. These households were subsequently offered a place to participate. This demonstrated that with more experience and evidence of how risks could be mitigated, consumers in vulnerable circumstances could participate in innovation projects.

Purchase

These projects have shown the importance of creating and presenting an offer that fits with their existing energy needs and is convenient for them. This could increase the expected numbers of households to participate and reduce the number of people dropping out during the activity. This is a learning from many different projects, but only a few ongoing projects showed an ambition to create an offer that is designed around people's existing wants and needs from energy. More activity like this could see an increase in the number of potential participants in both innovation activity and in a smart energy market long term.

In contrast to how innovation has helped LIV consumers to access products and services, recent activity has done little to help them purchase smart products and services. All projects either provided technology to the participants free of charge or used technology that the participants already had in their home or had access to free of charge (e.g. smart meters). Consumers have not had to buy or pay for technologies that are part of the innovation activity, however where tariffs have been tested and trialled people have paid for them through their energy consumption. In some circumstances, the fact that a project was part of their energy bill from their usual energy supplier meant that participants saw value in the activity and new tariff. For one participant in the Energywise trial, there was a sense of pride they could show their family the credit applied to their energy bill as a result of moving the household demand to times when it was cheaper (Johnson, 2020). This is especially true for those living on a low income where balancing their household budgets, including items that aren't necessarily a fixed cost (for example, their energy bill), is an everyday challenge.

Use

People who decide not to switch energy suppliers in the current market because they do not think the benefit is worth the time or effort may engage more with a different product and service if they think it is worth it. Recent activity has helped LIV consumers use smart energy products in different ways. We define customers as engaged/disengaged with the market according to whether or not they switch supplier (Ofgem, 2020). However what recent activity showed was that participants that were engaged in new products and services, including tariffs provided by an energy supplier, may not usually switch supplier or tariff. One

participant felt it was too much hassle “sorting all that [switching] out” but was happy to use their appliances at different times as part of a DSR trial (Johnson 2020). Consumers that may traditionally be regarded as disengaged may be disengaged from switching specifically, rather than any change related to energy products and services.

Numerous projects and evidence have reported LIV consumers enjoying using new devices and products in the home. Whilst low digital skills will be an obstacle for some people, recent activity has shown a broad range of consumers that digital devices and services can work well for and be enjoyed by the consumer. This isn’t to say everyone used things in the same way, but they could use it how they wanted to get the experience they enjoyed. There weren’t indications that recent innovation activity had explored opportunities for digitalisation to improve access to products and services.

3.4 How other markets have included low income and vulnerable consumers in innovation

Our interviewees described examples of how inclusive innovation has happened in other consumer markets. The approach taken by those we spoke to who have successfully innovated for LIV consumers in their sector was iterative, broadly user-centred and followed the process in Figure 3. They told us how they started with either a problem, for example the awareness that those with mental health issues struggle to manage their finances, or with the intention to extend their services to consumers currently being excluded. In both cases, they told us that they start by conducting discovery research to understand the consumers and the challenges they currently face, then prototype or trial potential solutions with these consumers. They were able to make sure all consumers can enjoy their products/services by running small trials (designed to prevent adverse outcomes causing harm). Engaging and designing for consumers with vulnerabilities was felt to have positive benefits to all consumers.

The four case studies below provide examples of successful innovation that has enabled LIV consumers to participate in other consumer markets.

Examples of innovation in the finance and housing sector

Case study 1: Capital One, personal lending

How innovation has helped LIV consumers participate: It allowed consumers in financial difficulty repaying a credit card to be able to ask for help and support when and how they wanted to. By designing support around consumer behaviours rather than socio-demographics or traditional risk factors, they were able to tailor support that worked with, not against, the consumers' behaviours. Innovations include enabling the setting up of digital payment plans, where consumers can self-serve via the app if they get into financial difficulty.

LIV consumers: Consumers who are struggling to manage their finances due to personal circumstances.

Innovation approach: Consider what it is about the consumers' behaviour which makes it challenging for them to engage and consider ways to mitigate for these challenges in the design of services. They found that designing for most vulnerable can help all consumers.

What we recognise now is there is a second order benefit, which is by looking after those most in need, actually, there is a universal benefit for all consumers, not just those who are vulnerable.

Stakeholder interviewee from this company

Case study 2: Fair Finance, personal lending

How innovation has helped LIV consumers participate: They developed financial products and provided credit to people outside mainstream financial services– those who typically use high-cost alternative and door-step finance. They provided access to more affordable finance, so they could buy things they needed (e.g. replace a broken fridge, buy internet access, pay rent/bills, including energy bills).

LIV consumers: Financially vulnerable and excluded consumers. Most consumers are on a low income, with part of their income from means-tested state benefits.

Innovation approach: Understand the consumer and the reasons for their current behaviour to design suitable alternatives for understanding the commercial risks associated with lending to them. Start small, work iteratively to test solutions and then scale what works.

Case Study 3: inclusive finance and banking

How innovation has helped LIV consumers participate: They help people with long-term mental health difficulties give others permission to manage their finances safely and flexibly, for instance to do small tasks on their behalf. This intends to preserve people's dignity and independence whilst allowing them to get support. It led to positive changes in spending habits for people who otherwise don't engage positively with their finances because they feel incapable or feel shame or anxiety. This tool has enabled people with mental health issues to address issues of financial difficulties and get help.

> *…just through having that second pair of eyes, [people] have been able to face up to getting out of debt and starting a debt recovery plan and come out of it having had suicidal thoughts before the study because of their money [and] mental health situation, being able to, kind of, face that because they have someone to talk to about it. So, those are the kinds of impacts that we're able to see now with just the simple prototype product that we've been using.*
>
> *Stakeholder interviewee from this company*

LIV consumers: people with long-term mental health issues, people with learning difficulties or dementia.

Innovation approach: They took an inclusive design approach and used the 4 phases of innovation. They started with the problem, explored the issues facing these consumers and then generated ideas to solve the problem, built and tested a prototype solution with LIV consumers. To date this company has mainly been undertaking grant-funded work and working in collaboration with bigger companies (e.g. banks, utility companies) helping them to develop proof of concepts designed to develop into long-term products for the company.

Case Study 4: Bromford Housing, social housing provider

How innovation has helped LIV consumers engage: They enable access to affordable housing for those who the regular housing market doesn't work for. Innovation activity includes the introduction of neighbourhood coaches, who build a relationship with residents which isn't just built around problem situations (e.g. when they're in rent arrears) but treating residents as having different needs. They enable consumer engagement in new innovations, such as smart heating controls and renewable energy sources, reduce rent arrears and reduce anti-social behaviour.

LIV consumers: Many tenants are LIV, including elderly residents at risk of loneliness, falls or ill-health; residents with health conditions or disabilities; those on very low incomes, homeless or escaping from domestic violence.

Innovation approach: They adapt solutions to suit the problem in hand – usually take an agile approach, and where possible, user-centred. Some of the innovation is self-funded and some is done in partnership with other organisations, such as the NHS.

3.5 Obstacles to LIV consumers participating in a smart energy market

There are reasons why innovation projects may not help LIV consumers participate in a smart energy market. This section discusses those reasons, differentiating obstacles that have been identified in innovation projects and those that might not exist in projects but might exist when LIV consumers try to participate in a smart energy market.

There is a prevailing view that it is not fair that some consumers could not be able to access the same benefits from a smart energy market because of factors largely out of their control. Obstacles faced by some consumers could also be important because their presence could slow down the energy transition needed to reach the Net Zero carbon emissions reduction target.

> *"We have seen innovation happening from within the market, but we think we may need to remove further barriers in order to accelerate the rate of innovation"*
>
> *BEIS and Ofgem (2019) Flexible and responsive retail energy markets consultation*

The prevailing view is that there is relatively little activity with LIV consumers compared to activity with other consumers. Innovation to date is not thought to benefit LIV consumers (Sustainability First, 2017). The imagined end users of innovative new products and services are often assumed to be tech-savvy, affluent, economically rational consumers who want to be and are in control of the services and products they use to actively manage their energy consumption (Strengers, 2013). These households are perceived as interested in new technologies, willing to take a risk on using a prototype and resilient if there are issues (Sustainability First, 2017). However, the sector hasn't done a substantial amount of work to find out what they are like and how to solve the problems they face. Incorrect assumptions may be limiting the potential for innovation to develop products and services that improve LIV consumers lives.

In the last 5 years there has been a number of projects that have described the potential obstacles that consumers may face (Sovacool, et al., 2019; Centre for Sustainable Energy, 2019; Delta-EE, 2019; Citizens Advice, 2019). Box 1 shows a simplified adaptation of potential obstacles identified in these and other recent studies.

These are obstacles to participating in the system. The obstacles arise when a person tries to interact with a system, rather than these things being obstacles just in their existence. For instance, not having digital skills is not a vulnerability about a person alone - it is only when that person tries to interact with the energy system (where a certain level of digital skills are currently essential for getting access and benefits) that not having digital skills is an issue. Some obstacles are specific to the energy market and others are found across many consumer

retail markets and social systems, such as searching for a job, getting health care or using a bank account.

- Finance
  - Capital for initial purchase of new technology
  - The stability of household income
  - Access to grants and loans
- Building and physical space
  - Permission to make changes to the building
    - Property owner
    - Local area planning
  - Availability of space to install new heating or energy technology
- Digital access
  - Home internet access
  - Digital skills
  - Accessibility of technology
- Engagement with energy market
  - Ability to switch supplier and service (e.g. because of energy account debt)
  - Capability to access information on alternative options in the market
  - Willingness to switch supplier and service
- Stability of household needs and circumstances
  - Health
  - Social relations within and outside the house
  - Financial vulnerability
- Proximate location
  - Availability of fuel types
  - Local acceptance of energy generation and demand types
  - Network availability

Box 1. Overview of potential obstacles to LIV consumers participating in a smart energy market identified in recent studies (Sovacool, et al., 2019; Centre for Sustainable Energy, 2019; Delta-EE, 2019; Citizens Advice, 2019)

The obstacles are also rarely experienced in isolation. It is common for a person to experience multiple vulnerabilities at a time (Ofgem, 2019) and this can exacerbate the risks of them not being able to participate as well as the impacts if they don't participate.

These obstacles show how low income and vulnerabilities may play a different role for future consumers being able to participate than it does at the moment. For instance, low digital skills does not currently stop the majority of UK consumers being able to use energy in their home in the same way as people with higher digital literacy. However, in the future, if services and products require consumers to be constantly interacting with devices and technology around the home than those with low digital skills may not be able to get the same experience of using energy as others.

The design of products and services could remove obstacles that prevent people participating. For example, if a product's connectivity was designed using 5G rather than in-home broadband then home internet access would no longer be an obstacle to them using that product. In another example, if people could access and use a battery that wasn't housed within their property, where there is not adequate space, this would no longer be an obstacle to them accessing battery technology and potentially demand-side response services. **Other obstacles will affect people's willingness to participate even once they are able to participate.** For instance, recent activity has shown that even where the obstacle of upfront capital cost of technology was been removed by providing it to the consumer for free, needing to move to a different supplier stops them being willing and able to take part.

Visions of what a 'fair' energy system might look like and what the potential barriers are, aren't reflected in the recent innovation projects analysed in this report. The obstacles in Box 1 have largely been created from existing research and expert opinions of what the future could be like. Some of them have been discussed in recent innovation activity but many cannot be evidenced because they would emerge later in the transition. For instance, currently many of the most commonly used low carbon heating systems (such as different heat pumps) require space within the property boundaries but often outside the house and so do not fit within the space left behind by an existing gas central heating boiler. This is why physical space and the building are often identified as an obstacle.

Demand Side Response and Time of Use (ToU) tariffs

ToU tariffs involve a variation in energy prices over the course of the day. This can be static, with set prices for different parts of the day (such as, Economy 7, where energy is cheaper overnight than it is during the day), or dynamic, where prices vary over time. Consumers can use these tariffs manually, meaning they change when they choose to use appliances such as washing clothes or charging an electric vehicle. Consumers can also allow third parties to control when a household draws energy from the grid using a variety of smart, DSR and storage technologies. There are different obstacles to participating in these options. Delta-EE (2019) estimated that ToU would have some of the highest barriers and affect the largest number of consumers compared to other future energy supply models.

How can innovation deliver a smart energy system that works for LIV consumers?

Flexible use of energy in the home

Without access to smart, automated control or storage technologies, consumers will need to alter their behaviour to change energy use in the home to take advantage of ToU tariffs and avoid expensive peak-time charges. This poses an obstacle to participation for anyone who is unable to be flexible with their energy consumption (Citizens Advice, 2019).

People on lower incomes are often those least able to manually use energy at different times. For example, families with young children (UK Power Networks, 2018; Energy Consumers Australia, 2020) and those in low-paid jobs, who are less likely to have flexible working patterns (Citizens Advice, 2019), are often less able to be flexible with when they use their energy. Other personal circumstances, such as health conditions, may not allow flexibility in when energy is used for medical equipment or heating. People on low incomes may have low annual energy consumption meaning that they can't be flexible with what little demand they do have (UK Power Networks, 2018).

Not everyone has control over the time appliances are used in their home. Energy use might be affected by personal circumstances, like when others are available to help with household chores such as cleaning or paying bills or when family members are visiting are using energy e.g. grandchildren and games consoles (UK Power Networks, 2018). It is also impacted by building and physical space: those who rent a room in a shared household can't control overall energy use or aren't allowed to run appliances at night (Citizens Advice, 2019; Delta-EE, 2019), and renters may have to use electricity to make up for something outside their control (e.g. poor central heating which requires secondary electric heaters) (UK Power Networks, 2018).

Being unable or unwilling to engage with the energy market is an obstacle to taking advantage of cheaper and avoiding high-cost peak energy, either through a lack of understanding of DSR or how to manage their energy use (UK Power Networks, 2018). Many people on low incomes do not have the time to think about energy consumption (Citizens Advice, 2019).

Automatic engagement with DSR and ToU

The automation of using energy flexibly in the home or the ability to store energy when it is cheap, to take advantage of ToU tariffs, requires up-front investment in DSR or storage technologies. This poses an obstacle to participation for those who are on a low-income, or who lack digital capabilities to access or use the required technologies (Citizens Advice, 2019; Centre for Sustainable Energy, 2019; Energy Consumers Australia, 2020; Ofgem , 2019). Other obstacles include a lack of space for storage technologies like batteries, or no control over which technologies and services are in the home (e.g. people renting from a private landlord) (Centre for Sustainable Energy, 2019). Engagement with, and trust of, the energy market is also required to relinquish control to a third party to perform automation, which can be a barrier to many consumers, not just those who are low income and vulnerable (Citizens Advice, 2019; Centre for Sustainable Energy, 2019; UK Power Networks, 2018; Energy Consumers Australia, 2020).

Obstacles to engaging with energy as a service

Energy as a Service (EaaS) could offer consumers a fixed price for the energy they use in their home, for example to keep their home at a certain temperature for a set number of hours a week, or for their hot water. Such a service might also include the cost of the equipment of delivering this, for example having a new heating system installed. It could include technologies that automate heating and power consumption (Citizens Advice, 2019; Delta-EE, 2019; Energy Systems Catapult, 2019). It could help increase consumer's trust because it gives them control of what they care about.

Whilst these services could remove the need for up-front investment in new technologies, those on low-incomes or with changing personal circumstances may still face obstacles in accessing these services due to too low or unreliable level of income. Building and physical space obstacles such as not having space for the technologies required or having permission to have it installed in their home could prevent some LIV consumers engaging. These services will require the use of smart-technologies to control them, and access to broadband, smart-phones and digital skills (Centre for Sustainable Energy, 2019). Digital obstacles could also prevent LIV consumers finding out about and choosing the best EaaS offers for their needs. Some areas may have limited services available e.g. in rural areas (Centre for Sustainable Energy, 2019).

Obstacles to engaging with Electric Vehicles

Available capital is an obstacle for LI consumers to purchase EVs (House of Commons Library, 2020). Building and physical space obstacles also exist, such as not having car parking space or permission to install a charge point at their property (HM Government, 2018). Workplace charging may be less available to LIV consumers who might be more likely to be in informal work or have no fixed work location. Digital access and skills are required to use and charge an EV, as well as to take advantage of the best tariffs for charging at home (House of Commons Library, 2020; Centre for Sustainable Energy, 2019).

Personal circumstances, such as disabilities, also affect consumers' ability to access and use this technology. For example, disabled parking bays are not equipped with suitable EV charging points that can be used by people with disabilities (Scottish and Southern Electricity Networks, 2020). Plugging in heavy, trailing chargers can be prohibitive for some consumers. Charge points are often in hard to access areas, close together, and bollards and cables make this even more problematic for some (Powells & Fell, 2019).

Obstacles to engagement with other products and services

The list above will also pose obstacles to engagement with other smart energy products and services that could benefit LIV consumers, for example auto-switching services. Building and physical space obstacles and a low income will exclude many from buying technologies like heat-pumps, batteries, hot water tanks in order to participate in energy efficiency or peer-2-peer energy services (Citizens Advice, 2019; Centre for Sustainable Energy, 2019). A lack of engagement with the energy sector or digital obstacles may lead to consumers being unaware of and missing out on the right services and offers (Centre for Sustainable Energy, 2019;

Energy Consumers Australia, 2020). There is not currently good enough information or tools to empower LIV consumers to manage their energy use (Energy Consumers Australia, 2020).

4. Maximising the potential of future innovation

Key insights

- To maximise the potential of future innovation, activity should take a human-centred approach. This would deliver products and services that address consumers' needs and solve their problems.
- Socio-demographic characteristics do not describe the needs consumers have or the problems they need solving. Different consumers could become vulnerable and low income in future to those that face difficulties in the current market.
- Future innovation would show how tariffs, technologies and business models could work for LIV consumers by building and testing options *with* these consumers.

Future funding should focus on:

- Future innovation projects should **overcome the obstacles** LIV consumers actually face. They will not discover how LIV consumers could purchase smart energy products and services in future if they give away the technologies free of charge or only work with people who already have it. Future projects should explore how LIV consumers could afford to purchase smart energy products and services.
- Future innovation projects should **identify the risks LIV consumers will face**. This will not occur if projects merely avoid the risks by working only with non-vulnerable consumers. They must work with LIV consumers to discover risks which emerge when they try to use smart energy technologies.
- Future innovation projects should establish how to **protect LIV consumers**. They should explore how to protect LIV consumers in a smart energy market, by designing and testing protections with people using smart products and services.

4.1 Introduction

Innovation for domestic consumers will be essential for the UK to reach Net Zero. The exact technologies that will be in people’s homes as part of that transition are not yet clear. What is technically feasible is one question but there is also a lack of clarity over what is commercially viable and appealing to consumers.

This chapter considers the observations and insights from recent innovation activity and research about innovation relevant to LIV consumers. This chapter describes how future innovation could deliver feasible, viable and desirable products and services in a smart energy market that low income and vulnerable consumers can participate in. The aim of this participation would be to maximise the ability of LIV consumers to participate and benefit from a smart energy market.

How can innovation deliver a smart energy system that works for LIV consumers?

This chapter focuses on the following research questions:

3. How will new innovation activity ensure low income and vulnerable consumers are engaged in this market?

4. How could innovation put them at the forefront of the smart energy transition?

Future low income and vulnerable consumers

Section 3.5 describes many reasons why consumers could become vulnerable and unable to participate in a smart energy market. It is not just because their home has poor energy efficiency, so their heating bills are high.

In existing work on fuel poverty and energy consumers in vulnerable circumstances, there is a tendency to talk about who is fuel poor or who is vulnerable in terms of their age, whether they have a disability, what type of housing tenure they live in, whether the property is connected to the gas grid or not and so on. This works well for when we are trying to reach a higher rate of people that fit within a top-down definition of who is in need and when the support doesn't depend on consumer participation to determine if it is successful or not. Annual payments such as Warm Home Discount and Cold Weather Payment are good examples of such support.

For LIV consumers to participate in a smart energy market there are different problems that need addressing and the solutions that are needed are different. Crucially, **how consumers use smart energy products and services will determine whether they provide the intended benefits to the system and the consumer.**

If products and services are not designed as people use them when they are in real homes, the benefits to the energy system could be less than intended. This could undermine the technical feasibility and the commercial viability of smart energy products and services. Also, if people can't get the experience they want from a product or service or it is too difficult to use, then they will not want to purchase it or continue to use it threatening its commercial viability.

4.2 Design of future innovation

This section discusses innovation related to how domestic UK energy consumers may participate in a smart energy market. The discussion suggests roles for national government, the energy regulator, the energy industry and anyone designing and delivering energy innovation in the future. How innovation could be designed is discussed in terms of what process innovation projects should follow, who it should innovate for and with and what areas funding should focus on.

What process should innovation projects follow?

Smart energy products and services require consumers to use them to see benefits to the energy system and ultimately our 2050 carbon emissions reduction target. Products and services will not deliver the carbons savings expected if they are imposed on people without consumers seeing benefit in using them. Instead it is important to put people at the centre of innovation.

> *"Great innovation extends beyond technical research and development"*
>
> *"Understanding people is important for innovators because, whilst technology can make new ideas possible, people determine whether they're successful"*
>
> *Innovate UK (2020)*

To maximise the potential of future innovation, **activity would take a human-centred design approach**. As discussed, this could be done by ensuring that future activity works on 3 lenses: technical feasibility, commercial viability and consumer appeal (Figure 2) through each phase of activity. By taking this approach and using relevant methods, innovation will not lock in technical decisions made on assumptions about an "average consumer" as an end user that then go on to lock out LIV consumers being able to access, purchase or use the product or service later in the innovation activity or in the smart energy market.

Applying the 3 lenses of innovation during the standard innovation process can result in a more efficient innovation process. It is cheaper to test ideas earlier in the process because you can change them very quickly. It is more expensive and slower to change things once you have built a technical solution. This sunk cost can lead people to launch solutions that will fail.

Future innovation would take a human-centred design approach by understanding the problem space and consumer needs in the Discovery phase of the innovation process. Previous chapters explained how few projects of those we analysed explicitly followed this innovation process but some end up choosing to go back to understanding consumers' needs once they had ascertained that the technical solution would not work for the consumers they were working with. Commentators have proposed many other potential obstacles may exist. More discovery work would help future activity produce solutions that consumers are willing to use as well as identify and, where possible, overcome reasons they have not previously been able to participate. People using energy do not want to use it in the same way (ETI, 2018). Using learning from the Discovery phase is a more efficient method for developing smart energy products and services that have the potential to be used by LIV consumers than developing the solution first.

> *Interviewer: But, isn't it quicker and cheaper to just go straight to the solution, rather than doing all of that discovery?*
>
> *Interviewee: It absolutely is, as long as you don't mind if it doesn't work. So, if it's just about going through the process and saying 'I've done it, here's my report*

> *finished.' Then great, do what you like. But, if you actually want to change people's lives, if you want something to get adopted, then you've got to involve the users, because everything revolves around the users.*
>
> *Involve interviewee*

Socio-demographic characteristics do not describe the needs consumers have and the problems they would like resolved. For instance, it is not age that is an obstacle, but low confidence using the internet (which can be present in any age and can be overcome at an any age).

> *what we found is, age is not a determinant factor to anything, like, lower levels of digital engagement, lower levels of good outcomes for consumers. And I think, some of our research has, kind of, actually shown that some of it's just learning curve, or the learning cycle of these people. It's not that they aren't capable, it's just that they aren't yet ready*
>
> *Involve interviewee*

Future activity that **builds and tests options with consumers would help understand how tariffs, technologies and business models could be designed in a way that creates a solution that LIV consumers could participate in.** Working in this way would result in new offers that people can understand the benefit of and are therefore willing to try. Whilst expert opinion is an essential part of delivering innovation activity, to rely on it to decide the problem space assumes that experts can express the needs of consumers accurately. As seen in projects, experts do not necessarily know what consumers want. In addition, consumers aren't always able to express what they want. For instance, in one project the team thought that consumers wanted to be able to set their room to be warm at a specific time. They introduced a 'smart warm up' feature that turned the heating on earlier on cold days to make the room warm in time. When they tested a prototype, it showed that some consumers disliked losing control of when the heating came on because the noise woke them up earlier on colder days. The team were then able to change the prototype to give them better control of when their heating came on. For instance, preventing someone making a radiator hot or keeping it quiet early in the morning by giving them heating controls with 'smart warm up' reveals they want to be able to decide when it gets hot or makes a noise (Energy Systems Catapult, 2020).

Who to innovate for and with?

Future low income and vulnerable consumers could be different than those that face difficulties accessing, purchasing and using energy in the current system. The discussion of the obstacles that people might face in chapter 3 demonstrated the variety of reasons why people may not be able to participate. Future activity will need to account for the differences within the group we refer to as 'low income and vulnerable'. Whilst low income is a relatively unambiguous term, there is far more diversity behind the vulnerability people may live with.

How can innovation deliver a smart energy system that works for LIV consumers?

Some people might be vulnerable because of the obstacles they face trying to participate and for other people vulnerability stems from the consequences of something going wrong during participation, which in the current system we'd refer to as those with additional needs. They are different problems that need different solutions. Some obstacles could be solved through innovative products and services. Other obstacles are more likely to be solved through changes in policy or legislation. If there isn't activity that seeks to overcome some of the obstacles, then they are likely to remain in place and significantly reduce LIV consumers' ability to participate in a smart energy market.

Creation and design of new products and services could overcome some obstacles for LIV consumers by not being designed for 'Mr Average' (Strengers, 2013). Recent activity has sought to ensure LIV consumer participate in innovation projects by removing the obstacles completely. This does not demonstrate how the obstacles could be overcome in a future smart energy market. For instance, by giving people technology for free as part of a project we might learn about the technical feasibility of the product or service, but we do not learn about the consumer appeal and the commercial viability of it (both are usually intrinsically related) in relation to the price of it or the way people might be able and willing to pay for it (e.g. small monthly payments over years rather than an upfront capital purchase).

> *I think that before [now], design process that wasn't iterative and wasn't using expertise by experience, it was using technical expertise as its primary way of understanding what can innovation do, what can new products and services do for people? And essentially, you're creating a shape that you hope people can fit into, generally.*
>
> *Involve interviewee*

Doing projects with non-vulnerable consumers in the hope that all risks relevant to LIV consumers will be discovered assumes that risks are purely technical and are not influenced by how the consumer interacts with the solution. The standard innovation process emphasises designing with and for the consumers rather than purely testing on them. In practice this means by using the standard innovation process and the 3 lenses, the end solution would not pose risks to the things that the consumers were especially vulnerable to. For example, the solution would not require a large upfront capital investment when it had been designed with and for consumers without access to available capital.

Consumers whose needs were rarely discussed in the design of innovative energy products and services but are likely to be low income and vulnerable in a smart energy market:

- People with mental health problems
- People with caring responsibilities
- People without access to the internet or without basic digital skills
- People renting their home from a private landlord
- People without significant savings or assets
- People with health issues specifically made worse by low indoor temperatures
- People with health issues that require private transport (e.g. those regularly visiting hospital for chemotherapy or those with certain physical mobility requirements for driving)
- People with English as a second language

Box 2. A list of LIV consumers whose needs are rarely explicitly designed for.

What areas should funding focus on?

Innovation can produce solutions that address consumer needs by delivering a specific outcome, rather than a specific product. Research with consumers shows that they value what they use energy for rather than the product or service that provides that (ETI, 2018). Heat as a service is one example of an outcome-based solution, that would be a change from consumers buying a heating system (technology) and using it to keep warm, to consumers buying the outcome of using energy in their home that they want. It allows innovators to find the 'best' way to provide that outcome. People will want a similar outcome from the service, to be warm, but may prefer different levels of service, for instance higher temperatures, or longer periods of warmth. There is growing interest from policy makers in the potential of Heat as a Service to help deliver carbon commitments. Governments are becoming increasingly interested in how they can design policies that encourage new, low carbon, heat as a service business models (Scottish Government, 2021; Danish Energy Agency, 2016). The prevailing view in the evidence and the interviews was that the design of products and services could determine whether LIV consumers can access, purchase and use smart products and services. What is clear is that there are topics that are coming up repeatedly as possible smart energy products and services that could be designed to work for LIV consumers. Below are the topics that have been identified in the evidence and through the interviews.

Problems and consumer needs that have been identified in the evidence for LIV consumers:

- Understanding how expenditure on energy relates to the experience of using energy in their home
- Understanding how energy can be used to support health-related problems and a healthy home environment

How can innovation deliver a smart energy system that works for LIV consumers?

- Understanding how people can live independently in older age in their current homes
- Understanding how smart products and services could support those at risk of self-disconnection and rationing energy
- Understanding how people living on a low income might use transport in the future

Products and services that have seen some development to date but could be prototyped and tested further for LIV consumers:

- Time of Use tariffs that are designed around existing household needs
- Energy as a Service designed to give people control of the outcomes they care about, enabling a service provider to deliver the outcome using the most appropriate smart technologies and services (e.g. DSR, smart tariffs)
- Products and services that may be shared amongst different individual households

Tariffs, technologies and business models that can use existing technology already in UK homes (e.g. smart meters, connected smart home tech) but aren't yet developed and scaled up for LIV consumers:

- Smart prepayment metering and the living services market, such as connected home safety, health and assistive living.
- Data-driven advice services to consumers using data from smart devices and technologies.
- Accessible websites with energy suppliers or service providers for a wider range of people, using modern technologies and devices.

Consumer protections in a smart energy market

One overriding feature of a smart energy market that is not mentioned above is the new consumer protections needed in a smart energy market. Current consumer protections may not be sufficient for new smart energy products and services (Citizens Advice, 2019; Energy Systems Catapult, 2019). Whilst there will be some high-level protections that apply to a range of products and services, terms and conditions could be different for individual products and services. Appropriate consumer protections could enable businesses to design suitable terms and conditions for their products and services.

The design of new consumer protections was seen as an essential part of LIV consumers being able to access, use and purchase new smart products and services. Some specific concerns were raised about consumers facing higher energy costs than they expected and not having access to information and skills to use new products and services. There have been attempts to quantify how new energy supply models could present challenges for different consumers (Delta-EE, 2019) and identify potential risks across the customer journey in a smart energy market (Energy Systems Catapult, 2019).

However, **very few projects explicitly explored how to design and test new protections.** Nonetheless, many projects did have to create protections and develop them during the innovation activity. There appears to be a lack of questioning assumptions at the start of the

project and of sharing and building on protections from previous projects. It is not possible to predict all the possible problems and prevent them from happening. Instead we will need a way for innovators to try new things, fail and fix them quickly before people are harmed and before they spread widely in the market (Energy Systems Catapult, 2019).

5. Risks and mitigations

Key insights

- The review identified 6 risks that could emerge as a smart energy market develops:
  1. LIV consumers cannot afford to purchase smart products and services
  2. LIV consumers may not benefit from smart products and services
  3. LIV consumers face greater risks if the product or service fails to work as expected
  4. Lack of data access reduces how much LIV consumers benefit
  5. Unfair distribution of system costs
  6. LIV consumers experience problems that prevent a smart energy market emerging
- Of these, the inability to afford and to access new services and products are the most widely acknowledged risks facing LIV consumers as a smart energy market emerges.
- If these risks emerge early in the low carbon transition, it could force regulators to restrict a smart energy market until adequate consumer protections are in place.
- Human-centred innovation could mitigate the development and size of these risks by improving the performance of products and services. The risk of unfair system costs is one of the most difficult problems to solve through innovation of products and services alone.

5.1. Introduction

Innovation is about creating something new and moving through a process to deliver a new solution so that it can be scaled up if successful. Innovation is appropriate when we don't know all the answers to how to deliver a technically feasible, commercially viable and appealing solution so inherently things will arise that we don't know about at the start.

The energy sector is well-versed in dealing with risks to domestic consumers as they arise, including with those who are living in vulnerable circumstances. This predominantly focuses to date on energy suppliers and distribution network operators, and their interaction with the consumer. Organisations that usually interact with the consumer don't currently include smart technology providers or energy-related service providers but Ofgem are regularly considering their role to different providers to consumers (e.g. third party energy products and services as mentioned in the HM Government 2020 Energy White Paper). Current protections for consumers have been created through iteration, responding and being updated depending on recent consumer experiences. We have seen this happen rapidly during 2020, when the impacts of Covid-19 resulted in new consumer protections for those who were struggling with energy debt or topping up prepayment meters.

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We know that smart energy products and services could result in changes to how and who the consumer interacts with to access, purchase and use energy in the future smart energy market. This could result in needing new consumer protections for all consumers, not just those living on a low income or in vulnerable circumstances (Energy Systems Catapult, 2019; Citizens Advice, 2020). However, significant evidence doesn't yet exist on what the risks are to LIV consumers from participating or not participating in the smart energy market. This chapter explores what risks could emerge, when and how innovation could prevent them. It considers the observations and insights from all the evidence reviewed, which includes recent innovation activity and research about innovation relevant to LIV consumers.

This chapter focuses on the following research question:

5. What risks could emerge when, and how could innovation prevent them?

The risks we are most concerned with here are those that could affect LIV consumers, although many are likely to apply to a range of consumers.

5.2. Risks that could emerge as a smart energy market develops

Risk: inability to afford to participate in a smart energy market

The costs of initial purchase, switching to, maintaining and using smart products and services are higher than they can afford, or they present more financial risk than they want to take.

- Those on a lower income cannot afford the technology to be flexible with their energy demand and move demand outside of most expensive times because of their everyday routine. This could result in people restricting energy use when they can, potentially to harmful indoor temperatures or restricting energy for basic needs (e.g. cooking a hot meal). Alternatively, this could result in higher energy bills because they can't reduce or move their energy demand (Neuteleers et al 2017; Chapman et al 2016). People on fixed working hours are often living on lower incomes working in lower paid jobs (Powells & Fell, 2019).
- Those on a lower income cannot afford the technology to be flexible with their energy demand without compromising convenience (Powells & Fell, 2019). Increasing the potential for poor consumer experience and unexpected energy costs when they are unable to be flexible.
- People in vulnerable circumstances were most concerned about not being able to understand how to use a product or device and accessibility issues (Citizens Advice, 2018).

Risk: Consumers in vulnerable circumstances may not benefit from smart products and services

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The design of products and services doesn't provide benefits to them or doesn't provide them with what they need (e.g. energy debt management or tight control of how much they spend).

- Companies don't see LIV consumers as desirable customers, e.g. assume they are all high cost-to-serve and do not innovate to provide services for them (Citizens Advice, 2019). As a result, there aren't appropriate services developed and available for them in the smart energy market.
- Increasing numbers of services and organisations interacting with consumers make it more complicated for vulnerable consumers to make organisations aware of their additional needs and could lead to some people with vulnerabilities not being identified as such (Citizens Advice, 2020).
- Poor consumer experience of smart products and services could erode engagement and trust in the energy market and the low carbon transition.

Risk: Consumers in vulnerable circumstances face greater risk if the product or service fails to work as expected

Consumers with health conditions, for instance, may experience more harm if they are without energy for any period of time.

- People living in vulnerable circumstances are at risk during supply interruptions or power outages and if living on a low income as well, they could not afford technology to increase in-home resilience (Scottish and Southern Electricity Networks, 2020)
- Increased visibility of energy use and costs could lead to self-rationing and self-disconnection by consumers that are concerned about the cost of their energy bill (Centre for Sustainable Energy, 2018; Ofgem, 2019; Hledik, et al., 2017).
- One project, Energywise, found that consumers didn't know how to report issues with smart products and services whilst using them because they were unfamiliar with them (UK Power Networks, 2018).
- Consumers can't get redress and resolve because new smart products and services they are using aren't covered by appropriate regulations (Citizens Advice, 2019; Energy UK, 2019; Ofgem, 2019; Energy Systems Catapult, 2019).
- High costs on Time of Use tariffs may lead to people using less energy and having consequences for their health and wellbeing (White and Sintov, 2020) although this study was not able to say this conclusively.

Risk: Lack of data access reduces how much LIV consumers benefit

Smart technology and services can provide new and more data about consumers that could be misused or used for commercial gain at the expense of consumer choice.

- Big data could allow companies to target specific customer groups using socio-demographic data, resulting in first-degree price discrimination (Ofgem, 2017).

How can innovation deliver a smart energy system that works for LIV consumers?

- Innovation is easier and cheaper for companies where digital data is available about consumer behaviours and preferences. Services for engaged consumers are more widely available and at lower cost than for those who are disengaged (Ofgem, 2017).

Risk: Unequal distribution of system costs

- The costs of electric vehicles will be subsidised for early adopters by those who can't afford to participate, depending on the timescale and mechanism (e.g. energy bills, general taxation) through which this is paid for (Sustainability First, 2020).
- Choices about certain solutions may lock future generations into using these solutions at certain costs (Sustainability First, 2020).
- People renting from private landlords could be exposed to system costs of other people using new tariffs and technologies but be restricted in what they themselves have access to (Citizens Advice, 2020).

Risk: LIV consumers experience problems that may impede the emergence of a smart energy market

- Some LIV consumers have negative experiences. Other consumers are put off participating in the smart energy market (Citizens Advice, 2018).
- Policy makers are forced to constrain the smart energy market to prevent more harm in future (e.g. the Energy Price cap).

5.3 The timing of risks and how innovation activity could mitigate risks

The first two risks – inability to afford to participate and unable to access new services and products - relate to access to smart products and services. These are the most widely acknowledged risks for LIV consumers that could emerge with the smart energy market. These risks are likely to emerge at the start of the smart transition and affect substantial numbers of people. For example, there were 4.5 million households in privately rented homes in the UK in 2018, which was a 63% increase on 2007 (ONS, 2019) and 5.3 million adults in the UK are internet "non-users" (ONS, 2019). As these examples imply, the people that will may not be able to afford to participate or unable to access new products and services could be quite varied in age, housing type and energy needs. Where these risks arise because of digital exclusion, there could be a general decreasing trend as the number of internet users increases and the number of people with internet access via smart devices increases (ONS, 2019).

However, **innovation could mitigate these risks by providing an evidenced understanding of the number of people affected and their wants and needs from energy.** For instance, there is currently very little understanding of what the UK population would be willing and able to do long term in terms of flexing their energy demand. With an understanding of the problem space and the use of the standard innovation process, innovation could develop new ways for people to pay for the technologies that would make them more willing and able to provide demand flexibility within the constraints of their everyday lives. Innovation of products

and services alone is unlikely to be able to mitigate risks where people live in a property owned by someone else, but it could make the changes more attractive, practical and financially beneficial. At the moment there aren't offers available to private renters that they would be able and willing to access but innovation could develop products and services that appeal to both landlords and LIV tenants. One example could be a level of service for heating that safeguards the property from damp and mould and that provides the residents with an adequate level of warmth at a lower cost.

Consumers in vulnerable circumstances may be at greater risk of being harmed if they do take part in innovation that fails to meet their needs. These emerge at the start of a transition but increase in size as more people participate in a smart energy market. This could affect some LIV consumers where someone else (their landlord for instance) has chosen the product or service they have to use. Sometimes this risk will affect people because vulnerability can be transient and temporary, so when they accessed the service or product they were in a different situation and less at risk initially than later on (e.g. they have surgery and are off work at home with limited mobility for 6 months).

These risks are more likely to emerge early in the transition. If a significant number of problems arise, regulators could be forced to restrict a smart energy market unless adequate consumer protections are in place. Consumers are likely to assume that adequate consumer protections exist even when they don't (Energy Systems Catapult, 2019; Citizens Advice, 2019). It may not be apparent a service isn't appropriate for them until they experience it (Energy Systems Catapult, 2019) or, as recent projects found, people often might not report problems that they experience (UK Power Networks, 2018). These risks could be locked in before the problems and the size of them are realised.

Innovation could substantially mitigate the development and size of these risks by improving the performance of products and services so they meet people's needs, work as expected and problems can be resolved. Monitoring and reporting in this space to date hasn't include what good performance by service providers is or collected information about poor service for consumers (National Audit Office, 2017). Innovation projects could design protections that enable all sorts of consumers to enjoy the benefits of smart energy markets. These projects will need to include LIV consumers because they may experience unique problems and the consequences could be worse for this group. Actions taken to protect this group will also reduce risks for all other consumers. The risks associated with increased availability of data could emerge later in the transition as products and services reach a substantial number of consumers in the market and the possibilities from combining data sets are realised. Designing and testing how consumers are informed about data they could share and how they could choose what data to share and with whom could mitigate some of this risk. LIV consumers have been found to be more concerned than other consumers about data privacy and violations (Citizens Advice, 2019) so innovation with a range of consumers over time could decrease this risk. Regulation and industry standards (such as the Energy Data Taskforce) could go a substantial distance to mitigating this risk and could happen in the near term before problems develop.

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Innovation could help manage the risks that the costs of a smart energy system fall unfairly, however, innovation alone will not be enough to entirely remove the risk. There is already concern that the costs of the energy system fall unfairly on those least able to pay (Frerk & MacLean, 2017). Innovation could result in lower cost products and services, resulting in overall lower system costs. Innovation could explore with consumers what they would be willing to pay in future and what for. But fundamentally the future of how to charge for the future energy system is a topic to be addressed by policy and regulation. Policy could look to mitigate risks by reviewing wider energy system policies, including how costs of infrastructure are recovered.

6. Recommendations for future innovation

6.1 Introduction

This chapter proposes recommendations for future innovation based on the analysis of current innovation activity, its potential in the future and the risks that may arise. This is the ideal time to do human-centred innovation because we do not know all the solutions that will make up a smart energy market in the transition to Net Zero. Effective solutions must be commercially viable and appealing to consumers, so innovation cannot just focus on technologies in isolation.

This chapter focuses on the following research question:

6. Where should future innovation focus?

6.2 Recommendations

Our recommendations revolve around using innovation to enable domestic energy consumers to participate more effectively in the UK smart energy market. Currently we are not seeing ideas become products and services that allow LIV consumers to participate in the smart energy market. Figure 1 illustrates how our recommendations will move ideas to products and services that mean LIV consumers can participate in the future market. By following the principles, innovation best practice and creating an innovation ecosystem, innovation activity will have more impact introducing products and services into the market. Commissioning a discovery evidence base would focus innovation activity on solving consumers' problems and improving their lives. Low regrets projects will remove obstacles that prevent LIV consumers accessing, purchasing and using smart energy products and services. These recommendations can be undertaken in parallel. Their impact will combine and build over time.

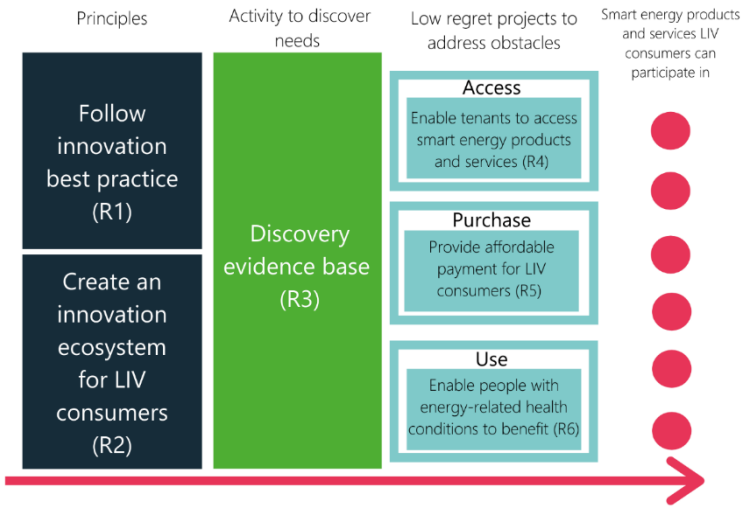

Figure 1. Diagram of main InvoLVe recommendations.

How can innovation deliver a smart energy system that works for LIV consumers?

Each box on Figure 1 is described in more detail in the section below. The timeline of the recommendations and their impacts are shown in Table 1.

	Recommendation	Near term	Medium term	Long term
Principles	**1. Encourage innovation to follow best practice human-centred innovation processes**	Define processes, stage gates and metrics	Implement	Every project is more successful, enabling more LIV consumers to participate in a smart energy market
	2. Create a publicly funded innovation ecosystem	Commission key parts of the ecosystem	Build ecosystem and start using it	
Activity to discover needs	**3. Commission a comprehensive and practical discovery evidence base**	Specify and procure	Deliver	Future projects are clear on what LIV consumers need and want from smart energy products and services
Low regret projects to address obstacles	**4. Enable tenants to access smart energy products and services**	Procure	Deliver	Projects remove barriers preventing LIV consumers accessing, buying and using smart energy products and services so more LIV consumers can participate.
	5. Provide affordable payment options for LIV consumers			
	6. Enable people with energy-related health conditions to benefit from smart energy products and services			

Table 1. A table showing timescales of delivery and impact for each recommendation.

6.3 Long-term principles for best practice innovation

We recommend innovation follows two principles to ensure many more LIV consumers can access, purchase and use smart energy products and services in the long term.

Recommendation 1: Encourage innovation to follow best practice, human-centred innovation processes

What we found: Projects typically try to persuade LIV consumers to trial existing technologies rather than finding out what consumers want and designing technologies they find appealing and useful. LIV consumers often do not want to participate in innovation projects, drop out of projects because they struggle to use the technologies, or use technologies in unexpected ways so projects do not learn what they set out to. Projects often exclude consumers they perceive to be risky to work with, but rarely present any evidence that the risk will materialise in the real world.

What we recommend:

- Follow a standard innovation process involving Discovery, Alpha, Beta and Live phases
- Create metrics to monitor projects at stage gates across all three lenses: consumer desirability, commercial viability and technical feasibility.
- Include a diversity of households and consumer types by default. Projects that exclude people should define the risk they are preventing, monitor whether the risk emerges and include all participants if it does not.

Timescales: This recommendation could be followed in near-term future innovation projects and the benefits would be delivered within the timescale of those projects.

How it helps:

- Discovery phases would increase the chances that LIV consumers will want to participate in innovation projects.
- Alpha phases would identify problems with proposed solutions and fix them rapidly and cheaply before projects spend more money developing and trialling solutions that will fail.
- Alphas phases would also identify and fix problems reducing the risk of harm.
- LIV consumers would be included unless there was a clear and transparent justification of the risk to them.

How can innovation deliver a smart energy system that works for LIV consumers?

Recommendation 2: Create a shared ecosystem that better supports innovating with low income and vulnerable households

What we found: Each project spends resource creating tools and processes that they dismantle when the project ends, for instance to protect consumers. New projects rarely learn lessons from previous projects. Projects are not equipping policymakers and energy sector innovators with detailed, robust information they can use to decide how the smart energy market should work for LIV consumers in future. For example, project processes protect current participants but do not consider how those protections could work in an ongoing manner in the market in future. Each project reports who participated and measures progress using different data in different ways making it hard to know what works for LIV consumers.

What we recommend:

- Develop and define common tools and processes many innovation projects can use to include LIV consumers. Update them based on every lesson learnt, so every future project benefits.
- Create a mechanism that collates detailed evidence on how smart energy policy and regulation need to change in future so it works for LIV consumers. For example, if all projects used common consumer protection processes and updated them, these could inform the design of consumer protection in the real market.
- Define a common basic dataset for each project to collect and report so their performance can be compared for different types of consumers. Monitor what sorts of consumer are involved in innovation projects and adjust funding priorities to ensure a diversity of LIV consumers are included.

Timescales: This recommendation could be started soon. The benefits would be seen over the medium to long term, as projects start using the ecosystem.

How it helps:

- Innovators will feel confident including LIV consumers in their projects because they can follow tried and tested processes that reduce the risks of working with them.
- Policy makers and regulators will have information about how they need to protect consumers in the real market, outside of innovation projects.
- Policy makers and regulators know what smart energy products and services work well for LIV consumers and where more action is needed to ensure LIV consumers can participate.
- Innovation projects in the energy sector would spend less time, effort and money developing different tools, processes, mechanisms and datasets on every project.

How can innovation deliver a smart energy system that works for LIV consumers?

6.4 Discover what consumers need and the obstacles they may face

Recommendation 3: Commission a comprehensive and practical discovery evidence base

What we found: Experts have proposed that various obstacles could potentially prevent LIV consumers from participating in the smart energy market. However, there is little evidence about whether these obstacles actually exist and if so, how large they are, who they affect already and how many they will affect in future. Without a comprehensive discovery base, innovators do not know what problems LIV consumers could face or what their needs are, so they focus instead on the subset of consumers who face fewer obstacles. Ultimately this could restrict the smart energy market from reaching its full potential.

What we recommend:

- Commission discovery research to understand what obstacles are actually preventing LIV consumers from being able to participate in the smart energy market and what would make them willing to participate

Timescales: This research could be commissioned in the near term and deliver in 1-2 years. It would improve the design of every subsequent innovation project leading to many more successful smart energy products and services for LIV consumers.

How it helps:

- This energy understanding of LIV consumers will support the inclusion of LIV consumers in a smart energy market.
- Funding can be directed to areas that will confidently produce products and services for LIV consumers in a smart energy market.
- Equips innovators with detailed evidence on the problems that LIV consumers have that they can use to design smart energy products and services that work well for all consumers.
- Provides access to data that innovators could use to design for a wide range of real, LIV consumers, not just early adopters, or hypothetical average consumers.
- Reduces the chances that investment is spent designing products and services that LIV consumers aren’t willing or able to access, purchase and use.

6.5 Low regret innovation activities to address potential obstacles

It is not possible to wait for perfect knowledge before beginning to solve this problem.

How can innovation deliver a smart energy system that works for LIV consumers?

We have 3 recommendations for projects that could start immediately. We consider these to be low regret because they address obstacles for LIV consumers identified in existing innovation activity and the current energy market, they affect large numbers of UK households and they are likely to persist into the smart energy transition unless directly addressed. These projects are highly likely to enable LIV consumers to access, purchase and use smart energy products and services by addressing certain obstacles. Table 1 in the Appendix shows the high-level analysis that was followed to identify the final 3 low regret recommended projects. The information in the table was created through a rapid assessment based on existing knowledge rather than a systematic evidence review.

Nonetheless, there is still some uncertainty. The experts we interviewed described various examples of where innovation projects, in their opinion, could have delivered better outcomes if they had conducted further discovery work to focus the project well. These projects should follow the standard process outlined in Recommendation 1 above to reduce these risks from occurring.

How can innovation deliver a smart energy system that works for LIV consumers?
As a result of the analysis in Table 1 in the Appendix, three individual low regret projects are recommended. One in each area of participation: access, purchase and use. Table 2 summarises the more detailed evidence for each of the 3 recommendations. The recommendations themselves are then detailed on the subsequent pages.

Table 2: Analysis for each of the 3 chosen recommendations.

Recommendation	Number of relevant UK households	Relative number of consumers that would face this obstacle[2]	Evidence of presence of obstacle in the current market
R4: Enable tenants to access smart energy products and services	4.6 million households in 2018-2019 (EHS, 2019), with a rise in low income households living in this sector in recent years (Bailey, 2020).	High score (4 out of 5)	Less likely to have a smart meter (EHS, 2019) but renters have a strong desire for a smart meter (Smart Energy GB, 2020). Lowest energy efficiency levels compared to other tenure types (EHS, 2019). Rental agreements given as a root cause of holding back installation of smart meters, with many tenants unwilling to pursue a dispute with their landlord (Smart Energy GB, 2020). No reason to think smart energy products and services will be any different.
R5: Provide affordable finance options for LIV consumers	14.2 million financially vulnerable adults (FCA, 2021). 9 million people used credit for basic households needs in 2017 (Ofgem, 2019)	Highest score (5 out of 5)	Interest in take up of smart energy technologies is related to cost and to the value that these products and services offer (Citizens Advice, 2018)

[2] As per analysis in Delta-EE, 2019. How accessible are future energy supply business models? A report for Citizens Advice. This score is the number of consumers that would face this barrier compared to other barriers this source identified, on a scale of 1 to 5.

			Between 62% and 70% of adults had £10k or less in available savings (i.e. not including assets) in 2020 (FCA, 2020), with 27-34% of adults have £1k or less.
R6: Enable people with energy-related health conditions to benefit from smart energy products and services	7 million households needing non-financial services in energy because they rely on health needs (Ofgem, 2019). 3 million adults with COPD in the UK (NICE), one of the most significant illnesses affected by low indoor temperatures. 2,800-6,000 excess winter deaths as a result of fuel poverty and the coldest homes (ONS, 2020). It is widely anticipated that the proportion of children and young people (who are already vulnerable to living in cold indoor temperatures) who are disabled will increase over the next decade (Sustainability First, 2017).	N/A This type of characteristic was not given in this source.	Over a 33% of disabled adults say their impairment has a significant affect on their energy costs (Scope, 2018). 2 in 3 disabled people think that products and services are not designed with them in mind (Scope Extra Costs Commission n.d) A recent Scope report made recommendations that information about the needs of customers with disabilities should be improved and suppliers should explore ways that smart technology and data could be used to more effectively support disabled customers (Scope, 2018).

How can innovation deliver a smart energy system that works for LIV consumers?

Access

Recommendation 4: Enable tenants to access smart energy products and services

Consumer type:

- People living on a low income and living in privately rented accommodation

Rationale: The number of people living in privately rented homes has been increasing, with over 4.5million households in the UK in 2017 (ONS, 2019). Consumers who rent their home were estimated to face the highest barriers to future smart energy business models (Delta-EE 2019). Many tenants live in homes with poor energy performance and need their landlord's permission to make improvements. This problem faces many people and will persist unless it is addressed.

Outcome: clear routes for private tenants to access smart energy products and services.

Purchase

Recommendation 5: Provide affordable payment options for LIV consumers

Consumer type:

- People who cannot afford to pay for smart energy solutions and technologies

Rationale: The number of people who are financially vulnerable – meaning over-indebtedness or with low levels of savings or low or erratic earnings – is now 14.2 million (FCA, 2021). In 2017 over 9 million people used credit to cover their basic households needs (Ofgem, 2019). The Covid-19 pandemic along with general trends suggests significant numbers of people will remain in this situation in future. The cost of smart energy technologies and smart home improvements may decrease over time but is likely to be above the available finances of many households for some time.

Outcome: clear routes for LIV consumers to afford smart energy products and services.

Use

Recommendation 6: Enable people with energy-related health conditions to benefit from smart energy products and services

Consumer types:

- People with heat-related health conditions
- People reliant on electricity for living healthy lives at home (e.g. people with stair lifts, nebulisers, dialysis machines)

Rationale: There are currently nearly 7 million households registered as needing non-financial services from their energy supplier or network operator because they rely on energy for health needs (Ofgem, 2019). The latest estimate of Excess Winter Deaths (ONS, 2020) would mean between 2,800 and 6,000 people died of fuel poverty and cold homes in winter 2019 and

2020[3]. Morbidity will clearly affect a much higher number of people on top of this. There is nothing to suggest that the number of people living with health conditions that require energy will decrease in the future, so this is an area that will always be relevant in the future energy market.

Outcome: Smart energy solutions that work for people with energy-related health conditions.

6.6. Potential LIV consumers of interest for future innovation

The evidence suggests that comprehensive discovery research would build a detailed and practical picture of which LIV consumers could benefit from smart energy products and services in future (Recommendation 3 above). However, the evidence review and stakeholder interviews pointed towards four groups of LIV consumers who already appear to have specific needs and problems that smart energy products and services could help solve. Many live with vulnerabilities or face obstacles that have prevented them from participating in previous innovation activities. These four groups are described below.

1) Digitally excluded consumers

Whilst areas with access to broadband and the number of UK adults with basic digital skills is improving, consumers who cannot use the internet (don't have access or don't have the skills) are likely to be 'left behind' unless products and services are designed with them in mind. The domestic retail energy market is likely to be increasingly digital in the way it offers services, allows people to buy and use services.

2) Consumers that regularly self-disconnect from their prepayment meter

Smart products and services could provide consumers with more information about costs of their energy at different times.

3) Consumers that have chosen to have a smart prepayment meter installed

These consumers are willing to access and use a new device in their home and see benefits of a smart meter, such as top-ups remotely, rather than going to a shop to add credit, and access to smart tariffs. They may be willing to access and use other new products and services that meet their needs.

4) Consumers with restricted mobility

Half of people in the UK with a limiting physical or mental disability have mobility impairments (over 6 million people). It would be useful to design smart energy products and services that these consumers can physically use (e.g. smart charging points for electric wheelchairs, accessible electric vehicles and charge points).

[3] It is estimated that 10%-21.5% of excess winter deaths are directly attributable to fuel poverty and the coldest 25% of homes (PHE, 2014).

7. Conclusion

Significant innovation will be required to achieve Net Zero. The evidence shows that, at present, LIV consumers are not fully involved in many innovation projects. This could create a future market that LIV consumers are unable to participate fully in.

Other sectors have successfully innovated with LIV consumers. They apply a human-centred innovation process. The energy sector could apply this same process to deliver smart products and services that work for LIV consumers. Building a shared innovation ecosystem and commissioning a robust discovery evidence base could catalyse this innovation and accelerate the emergence of a smart energy market LIV consumers can participate in.

There are clear areas where innovation activities could remove barriers preventing many LIV consumers accessing, purchasing and using smart energy products and services. These would focus on private tenants, affordable finance and people with energy-related health conditions. Together they could radically increase the number of people able to participate in a smart energy market.

It is worth taking immediate steps to include LIV consumers who might easily benefit from smart new energy products and services, those consumers who are digitally excluded, those who regularly self-disconnect, those with smart prepayment meters and those with restricted mobility. By applying standard best practice innovation processes deployed in other sectors, the energy sector could find many ways smart new products and services could benefit these people.

It is urgent that the energy sector takes these opportunities so it can create a future Net Zero society that low income and vulnerable consumers are also able to enjoy living in.

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Appendix

Table 1. Rapid analysis of the proposed obstacles for LIV consumers participating in a smart energy market (see Box 1 p21) to become low regret project recommendations in InvoLVe. Indicative estimates have been made where evidence was not readily available.

Obstacles		Likelihood of the obstacles being present in the future smart energy market	Relevance to LIV consumers specifically	Number of LIV consumers it will affect	Estimated impact on LIV consumers' participation in smart energy market (1 is low, 5 is high)	Is this an InvoLVe low regret recommendation?
Finance	Capital for initial purchase of new technology	High	High	High	5	Yes – Recommendation 5
	The stability of household income	High	High	Medium	3	No
	Access to grants and loans	High	High	Medium	4	Yes – Recommendation 5
Building and physical space	Permission to make changes to the building	High	Medium	High	5	Yes – Recommendation 4

Obstacles		Likelihood of the obstacles being present in the future smart energy market	Relevance to LIV consumers specifically	Number of LIV consumers it will affect	Estimated impact on LIV consumers' participation in smart energy market (1 is low, 5 is high)	Is this an InvoLVe low regret recommendation?
	Availability of space to install new heating or energy technology	High	Unknown	Unknown	2	No
Digital access	Home internet access	Low	High	Low	3	No
	Digital skills	Low	High	Low	4	No
	Accessibility of technology	Low	Medium	Low	3	No
Engagement with the energy market	Ability to switch supplier and service	Low	Medium	Low	2	No

Obstacles		Likelihood of the obstacles being present in the future smart energy market	Relevance to LIV consumers specifically	Number of LIV consumers it will affect	Estimated impact on LIV consumers' participation in smart energy market (1 is low, 5 is high)	Is this an InvoLVe low regret recommendation?
	Capability to access information on alternative options in the market	Low	Medium	Low	2	No
	Willingness to switch supplier and service	Unknown	Medium	Unknown	4	No
Stability of household needs and circumstances	Health	High	Medium	High	4	Yes – Recommendation 6
	Social relations within and outside the house	Unknown	Low	Unknown	2	No
	Financial vulnerability	High	High	High	4	No

Obstacles		Likelihood of the obstacles being present in the future smart energy market	Relevance to LIV consumers specifically	Number of LIV consumers it will affect	Estimated impact on LIV consumers' participation in smart energy market (1 is low, 5 is high)	Is this an InvoLVe low regret recommendation?
Proximate location	Availability of fuel types	Low	Low	Low	1	No
	Local acceptance of energy generation and demand types	Unknown	Low	Unknown	Unknown	No
	Network availability	High	Low	Unknown	Unknown	No