Department for Energy Security & Net Zero

CATAPULT Energy Systems

Inclusive Smart Solutions: Final Report

September 2025

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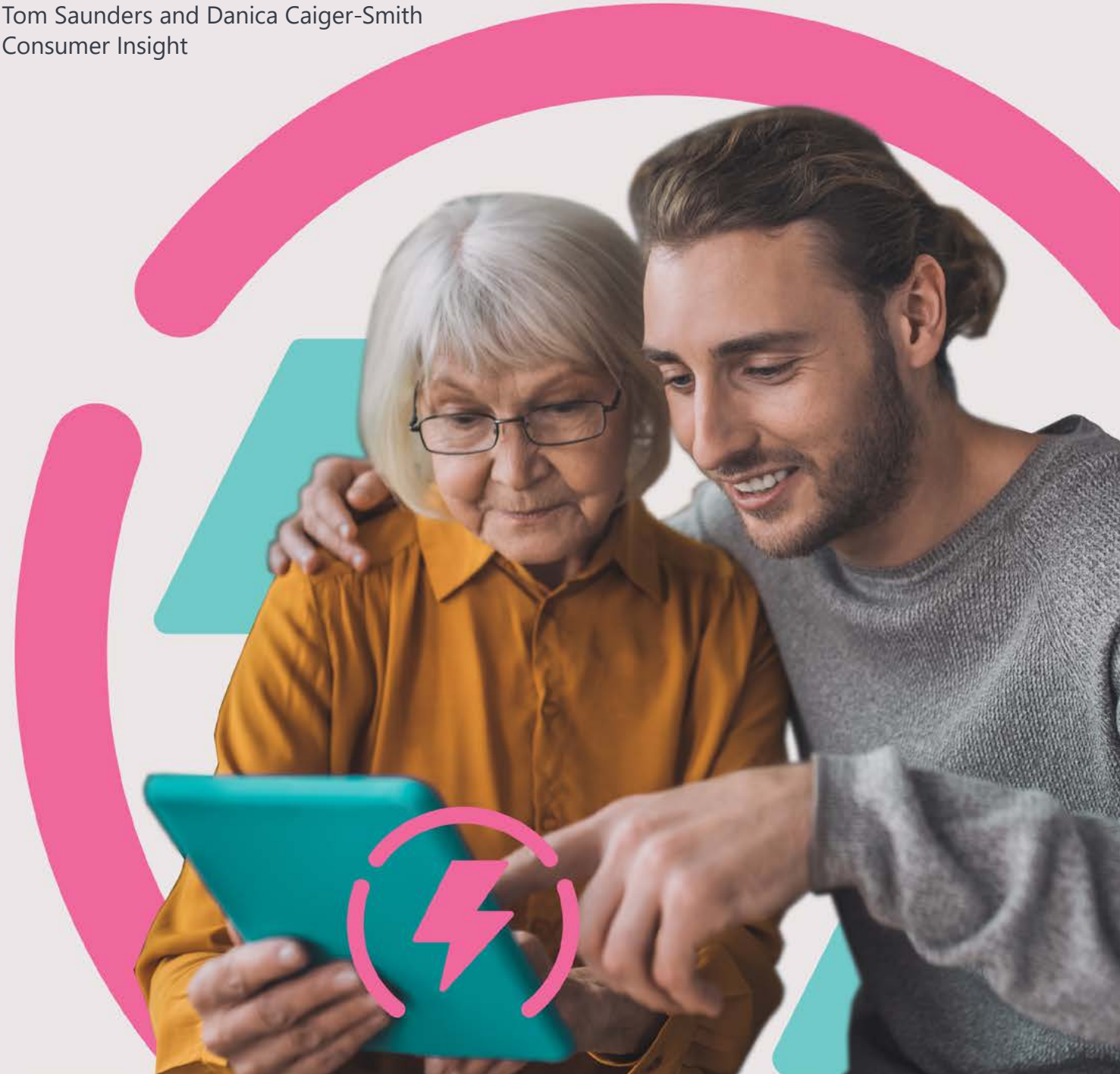
Consumer Insight



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1. Executive summary

1.1 Context

A smart and flexible future energy system that works for all consumers is critical to achieving Net Zero. Innovative solutions designed to support flexibility will play an important part in bringing about the transition to a future energy system. Whilst these innovations present clear opportunities and benefits, there is a risk that certain groups of consumers may be inadvertently disadvantaged or excluded, especially low income and vulnerable (LIV) consumers[1,2]. For innovators, a future energy system means developing inclusive solutions suitable for all, not just the able to pay. An understanding of the specific barriers faced by LIV consumers in engaging with a future energy system, and of how innovators can best meet these challenges, is therefore crucial. It is at this juncture that the Inclusive Smart Solutions (ISS) programme was positioned.

1.2 Approach

The ISS programme focused on understanding and addressing the barriers faced by LIV consumers in a future energy system, through original research and subsequent testing of solutions geared towards increasing the engagement of LIV consumers. This project was preceded by Project InvoLVe[3] (Department for Business, Energy & Industrial Strategy, 2021) and was funded by the Net Zero Innovation Portfolio (NZIP), commissioned by the Department for Energy Security and Net Zero (DESNZ). Energy Systems Catapult (the Catapult) have designed and led the delivery of the ISS programme, with support from delivery partners, Ipsos, TPXimpact and Carbon Trust.

The programme comprised two main phases: Phase 1 aimed to understand the barriers facing consumers in participating in smart and flexible energy. Phase 2 aimed to develop and trial (up to) four innovative smart solutions with consumers, including representation from those identified as facing barriers in Phase 1 and prior research.

Research in Phase 1 was undertaken by the Catapult and Ipsos. Phase 1 included background research, and quantitative and qualitative primary research strands, including a nationally representative survey, workshops and interviews. Four solutions were developed and tested during Phase 2: Repowering Homes,

[1] For this programme, LIV includes all energy consumers for whom an accessibility, usability or affordability issue may exist or arise in the transition to a smart, flexible energy system, making it disproportionately challenging for these consumers to benefit from new technologies, markets and business models.

[2] Department for Business, Energy & Industrial Strategy [BEIS] (2022). Flexibility innovation programme: Inclusive smart solutions programme; Market engagement event. https://assets.publishing.service.gov.uk/media/6745c889cdd295aea88098e5/inclusive-smart-solutions-market-engagement-event-december-2022.pdf

[3] BEIS (2021). How can innovation deliver a smart energy system that works for low income and vulnerable consumers? Project InvoLVe. https://assets.publishing.service.gov.uk/media/60cc5d47d3bf7f4bd6a9bd29/project-involve-smart-energy-system-low-income-vulnerable-consumers.pdf

Changeworks (Smart Tenant Smart Home), Homely Assist and equiwatt. These innovative solutions were shortlisted based on consumer impact, deliverability, and feasibility.

This report focuses primarily on the over-arching findings and insights from Phase 2 of the ISS programme, though a summary of Phase 1 can be found in Section 3.

1.3 Findings

Phase 1 of the ISS programme established seven characteristics which are indicative of households most at risk of being 'locked out'[4], or missing out on the benefits, of a smart, flexible energy system. These relate to income, tenure, occupancy, health and disability, metering, and housing type; and include the identification of a previously underacknowledged group: those living alone. Whilst this list of characteristics is by no means exhaustive, the research in Phase 1, by way of its representative sample, has provided a strong foundation upon which innovation can be targeted.

Phase 2 established, developed and trialled four distinct, innovative solutions geared towards facilitating LIV consumer engagement in a future energy system. The diversity of innovations has led to a comprehensive range of outcomes. A synthesis of evidence from across these four trials has been provided through consumer, business and commercial and policy and regulatory perspectives.

LIV consumers may have difficulty in finding out about energy flexibility; experience barriers to accessing smart solutions; have disproportionate purchasing barriers for smart products and services; lack the means to use energy in a flexible way; and experience disproportionately lower rewards and benefits from flexibility. Innovators may benefit from undertaking further engagement with social landlords and other ecosystem partners (e.g. consumer advocacy groups), evidencing the value of inclusive smart solutions, and considering all available financing options. Existing policy and regulation may not adequately facilitate consumer engagement with smart solutions or social landlords, do not encourage consumer advocacy groups onto the smart solutions journey in order to support LIV consumers, do not overcome issues with data matching and sharing, and do not adequately support small and medium enterprises. Overall, findings indicate barriers for both LIV consumers and innovators in the current market and policy space.

[4] We do not wish to imply that consumers may be permanently consigned to a state of exclusion from future, smart energy. The terms 'locked out' and 'excluded' are used to denote a relative likelihood of missing out on the benefits of future, smart energy.

1.4 Conclusions & Implications

The ISS programme has delivered on its ambitions to further an understanding of consumer barriers to a smart, future energy system, and to develop and trial innovative solutions to support consumer participation. The devised approach of working across delivery partners, innovators and experts with lived experience has been validated, and provides a blueprint for further work across the energy industry and government when developing innovative propositions for consumers. Several insights and implications have been identified and reported from this research, from macro-level policy insights to micro-level consumer and user considerations. We conclude that any action taken to improve LIV consumers' uptake and use of inclusive smart solutions should adhere to three high-level principles:

Smart solutions should help LIV consumers meet their needs

It should be easy for LIV consumers to access and use smart solutions

LIV consumers should feel able to trust what they are offered

As a result of these we have designed 7 recommendations:

- Help LIV consumers make informed, value-based decisions about participating in flexibility, and help them shift their consumption.
- Leverage flexibility to make it easier and more affordable for LIV consumers to meet their heating needs.
- Enable holistic approaches to increase uptake of smart solutions and encourage LIV consumers to use them in a smart, flexible way.
- Enable new asset ownership models so LIV consumers can access assets – and the benefits they enable – without owning them.
- Encourage smart-as-standard installations which are easy to use and meet household needs.
- Ensure the benefits and parameters of sharing (and continuing to share) data are clear to consumers.
- Ensure regulation and consumer protection keep pace with an evolving market.

1.5 Limitations

Each solution in the ISS programme has provided unique insight to the challenges faced for the particular technologies and services in question. Future programmes will need to focus on a similarly diverse range of solutions, building upon the findings and conclusions drawn here. Timescale limitations have precluded the full market launch of the innovative solutions, which should be a priority of future programmes.

Additionally, this research has drawn on LIV consumers from across the groups identified in Phase 1 and prior research, and has included consultation with ecosystem stakeholders. However, future research will need to take a more targeted and structured approach to ensuring the representative participation of consumers and stakeholders within innovator research projects, to aid in further understanding their needs.

2. Introduction

2.1 Background

A smart and flexible future energy system that works for all consumers is critical to achieving Net Zero. Yet, it remains disproportionately difficult for some consumers to access, purchase and use smart energy technologies, particularly low income and vulnerable (LIV) consumers. As well as creating challenges to meeting Net Zero, this poses a risk to the maturity of a smart and flexible energy market, and of creating a 'multi-tier' system whereby some consumers benefit directly from Net Zero and others miss out or become further disadvantaged, undermining public trust and support. As well as playing a key role in moving towards Net Zero, LIV consumers could stand to benefit from smart energy technologies and solutions, provided the right engagement mechanisms are in place. Ultimately, failing to act on behalf of the low income and vulnerable now may have consequences for all consumers as well as the network. Neglecting key consumer groups will make it more difficult to effectively achieve the UK's Net Zero targets.

Work previously undertaken by Energy Systems Catapult (Catapult) as part of Project InvoLVe sought to understand how innovation could enable LIV consumers to participate in a smart and flexible energy system. The review summarised evidence in relation to how LIV consumers can engage and their barriers to participation, and how existing and future innovation might facilitate engagement. Several risks that could emerge were identified, including to LIV consumers and to the development of the smart, flexible energy market itself. For example, LIV consumers may not benefit from smart solutions, which in turn may impede the development of a smart, flexible energy market overall. Some of the key recommendations included a need to build a comprehensive evidence base to unearth the needs and problems LIV consumers might face; encouraging innovators to adhere to best practice principles in supporting all consumers; and encouraging LIV consumer access, purchase and use of smart energy solutions.

The Inclusive Smart Solutions (ISS) programme was conceived as a result of Project InvoLVe, in conjunction with The Smart Systems and Flexibility Plan (UK Government, 2021)[5] and Ofgem's (2019) Consumer Vulnerability Strategy 2025[6]. The project was funded by the Net Zero Innovation Portfolio (NZIP) and commissioned by the Department for Energy Security and Net Zero (DESNZ).

[5] UK Government (2021). Smart Systems and Flexibility Plan 2021. https://www.gov.uk/government/publications/transitioning-to-a-net-zero-energy-system-smart-systems-and-flexibility-plan-2021

[6] Ofgem (2019). Consumer Vulnerability Strategy 2025. https://www.ofgem.gov.uk/decision/consumer-vulnerability-strategy-2025

The ISS programme builds upon previous work and insights developed by the Catapult over a number of years[7], focusing on key gaps and building on recommendations in identifying and tackling barriers to engagement of LIV consumers in a smart future energy market through supporting innovator development. In doing so, this programme advances understanding of meeting the needs of LIV consumers, and guides the direction of future innovative solutions within a smart, flexible energy market.

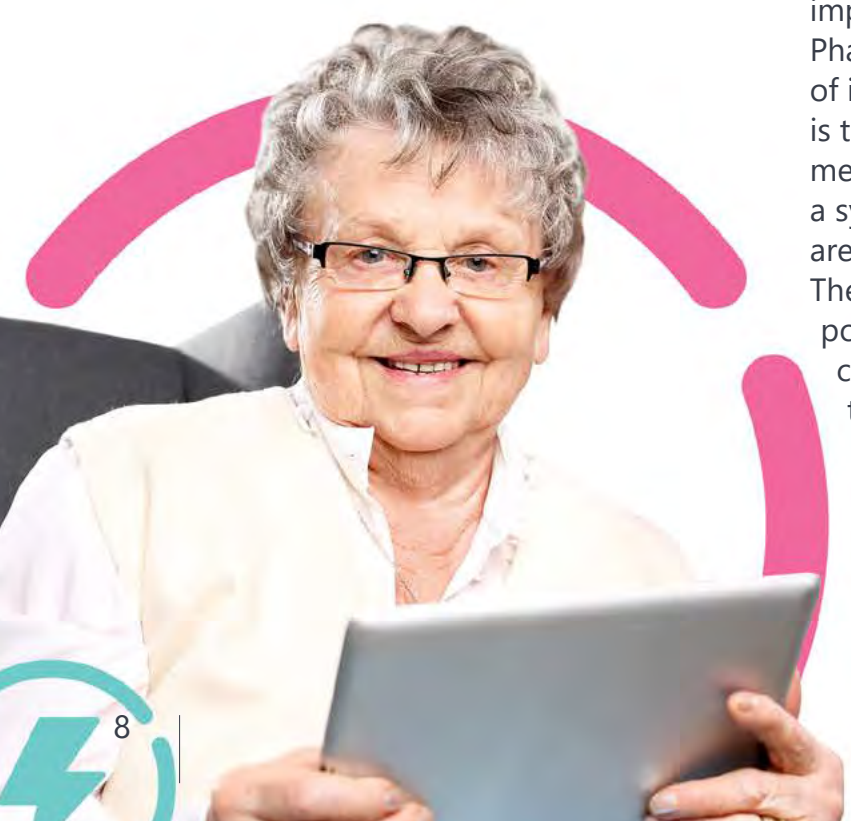
2.2 Aims

The ISS programme has sought to:

- provide a better understanding of the barriers faced by LIV consumers in the transition to a smart, flexible energy system, through a review of existing literature about LIV consumers and flexibility, which in turn informed the objectives and design of new primary research;
- develop and trial a suite of innovative solutions that will facilitate increased participation of LIV consumers in the emerging smart, flexible energy system.

In targeting these broad aims, the programme has contributed more widely to an understanding of how LIV consumers currently engage in the energy system, and how LIV participation – and that of consumers more generally – might be facilitated in future through the development and deployment of innovative smart solutions.

The purpose of this report is to provide an overview of outcomes following completion of the ISS programme, with respect to the approach, main findings, conclusions and implications. Emphasis has been placed on Phase 2 of the programme, where the majority of insights have been generated. This report is therefore not intended to provide detailed methodology and outcomes; rather, it offers a synthesis of programme outcomes which are geared towards a wide array of audiences. The report may be of interest to industry, policymakers, consumer advocacy groups and consumers with an interest in supporting those in vulnerable circumstances to better engage in a future energy system.



[7] Energy Systems Catapult (2017). Smart systems and heat. https://es.catapult.org.uk/case-study/smart-systems-and-heat/

2.3 Programme methodology

The ISS programme began in September 2023 and was completed in March 2025. Aligning with the two broad aims outlined above, the ISS programme consisted of two phases.

Phase 1: Primary research (6 months)

Phase 1 comprised a background review, alongside primary quantitative and qualitative research. The quantitative research involved a survey (total survey N = 6202), of which 69% belonged to at least one of the groups found to be more likely to be locked out of a smart, future energy system. The qualitative research included three deliberative workshops, and interviews which targeted the most vulnerable consumers.

Running alongside the primary research was a separate open innovation workstream, geared towards identifying, onboarding and refining innovative solutions to meet the objectives of Phase 2. Innovative solutions were identified using an appraisal framework (see Figure 1), through clarification questions, interviews and a feasibility assessment. These solutions showed promise for the programme's objectives and delivery parameters, and covered a range of LIV consumers and solution types.

Phase 2: Innovative solutions trials (12 months)

Phase 2 consisted of the development and trialling of a set of innovative solutions aimed at improving the engagement of LIV consumers in smart and flexible energy. Four solutions were tested during Phase 2: Repowering Homes, Changeworks (Smart Tenant Smart Home), Homely Assist and equiwatt. Consumers found to be at most risk of being excluded from a future energy system – established in Phase 1 – were targeted during this phase. A range of LIV consumers (n = 96) took part in in-depth research as part of the trialling across the four solutions. Additionally, the business and commercial modelling work incorporated desk research and stakeholder interviews.

The four solutions consisted of service-based and technology-based propositions, and aimed to improve LIV consumer engagement via access, purchase and use. The scope of each service is introduced below.

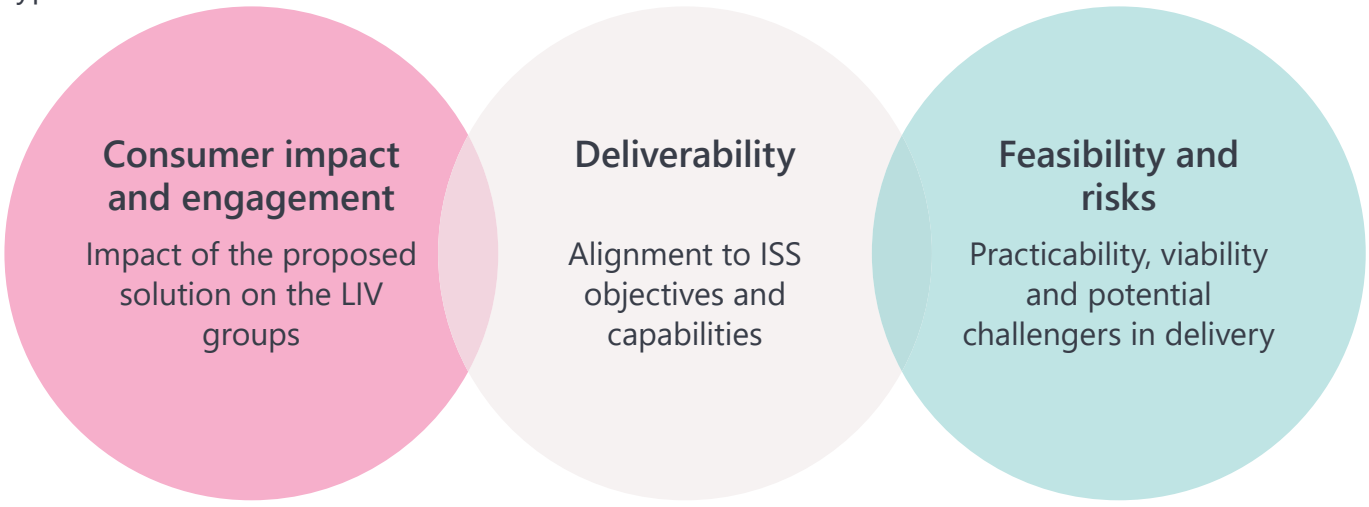


Figure 1. The appraisal framework for identifying innovative solutions

2.3.1 Solution providers

Changeworks: Smart tenants smart homes

The Changeworks solution comprised a business model that enables LIV consumers to access low carbon technologies by maximising savings or financial benefits of flexibility services without relying on onerous consumer engagement and control of their in-home energy assets. The intended LIV consumer group was predominately social housing tenants, with the potential to work with any rented home.

The scope of support initially planned to be delivered to Changeworks in ISS Phase 2 included:

- assessing the as-is service, define hypotheses in the proposal and prioritise areas of focus for hypothesis testing;
- creating prototypes to illustrate aspects of the proposed solution and recruit up to 20 relevant social housing tenants to test the prototypes with by way of interviews and workshops;
- designing a viable business model;
- developing an end-to-end and front-to-back minimum viable service;
- creating a full commercial model and explore financing requirements for the solution;
- testing at least the onboarding experience of the service with 10–20 relevant social housing tenants.

equiwatt

equiwatt provided a user-friendly platform through which LIV consumers can be financially rewarded during Demand Flexibility events by reducing energy consumption during peak times. The solution aimed to make this flexibility service more accessible to those with low digital literacy.

The scope of services initially to be delivered in ISS Phase 2 was to:

- define hypotheses and prioritise areas of focus;
- prototype different solutions and test prototypes with up to 20 relevant LIV ScottishPower customers;
- design a minimum viable service for an end-to-end householder journey;
- run a business model health check on the assumed consumers (i.e. users of the service);
- test the usability of digital prototypes and provide user experience and user interface support;
- trial the product and experience with up to 20 LIV target consumers.

Homely Energy

Homely offered a digital platform designed to intelligently control heat pumps whilst providing financial benefits, lowering running costs and improving comfort. The intended LIV target group were those in rented homes, those with health needs for additional comfort and those with no or low digital literacy.

The scope of services initially to be delivered in ISS Phase 2 was to:

- assess the as-is product and service, define hypotheses and prioritise areas of focus;
- prototype different solutions and test prototypes with up to 20 relevant LIV consumers, remotely and in-person;
- develop a working prototype product including the backstage and end-to-end minimum viable service (MVS);
- run a business model health check on the assumed consumers (i.e. users of the service) and customer (i.e. purchaser of the service – in this case, different to the user);
- test the working prototype with up to 20 relevant LIV consumers and users;
- run an in-home trial with up to 20 homes through the ESC's Living Lab, assuming it is appropriate;
- design a detailed commercial model.

Repowering London

Repowering London proposed a service that helps LIV consumers living in communal flats or homes with access to shared Low Carbon Technologies. The service is oriented around property surveys and retrofit design, involving community engagement and co-design. There was an alpha stage with working prototypes created, and there was a need to refine the design of the service journey and the requirements to deliver it, whilst recognising LIV consumer needs.

The scope of services initially to be delivered in ISS Phase 2 was to:

- assess the as-is service, define hypotheses and prioritise areas of focus;
- develop a viable business model design;
- prototype communications approaches and test with up to 30 households within the Repowering area and community;
- develop a minimum viable service for an unmoderated test with up to 30 households within the Repowering area and community;
- test consumer appeal with a large number of target LIV consumers;
- design a commercial model and financing requirements.

2.3.2 Project partners

The Catapult has led the ISS programme, providing programme design, management, oversight and synthesis of findings; with support from delivery partners TPXimpact (TPX), delivering research and design development, Carbon Trust (CT), delivering business and commercial modelling, and Ipsos, delivering primary research during Phase 1.

Energy Systems Catapult

Energy Systems Catapult was set up to accelerate the transformation of the UK's energy system and ensure UK businesses and consumers capture the opportunities of clean growth. We are an independent, not-for-profit centre of excellence that bridges the gap between industry, government, academia and research. We take a whole system view of the energy sector, helping us to identify and address innovation priorities and market barriers to decarbonise the energy system at least cost.

To overcome the systemic barriers of the current energy market, we work to unleash the potential of innovative companies of all sizes. Helping them to develop, test and scale the products, services and value chains required to achieve the UK's clean growth ambitions as set out in the Industrial Strategy.

As the lead partner in the ISS Programme, the Catapult has provided management, governance, and impact monitoring and reporting throughout the project; and worked with the solution providers to assure they are having the impact they require.

Experts by Experience

We wish to acknowledge the 11 experts by experience that took part throughout the ISS programme, whose support helped shape the design and development of each of the innovative solutions, and whose insights were invaluable during participation in the Phase 1 primary research and the subsequent trialling of solutions during Phase 2. Their lived experiences of vulnerabilities proved instrumental in the successful delivery of this programme.

TPXimpact

TPXimpact is a purpose-driven organisation with experience in the public, private and third sectors. They support organisations to deploy programmes, projects and products that enable them to deliver better services and experiences.

Combining their heritage with expertise in human-centred design, data, experience and technology, TPX work alongside their clients to find new ways forward. As a partner in the ISS Programme, they have provided design expertise, including for trials, and delivered the research and design development work with the solutions providers.

Carbon Trust

Carbon Trust's mission is to accelerate the move to a decarbonised future. They partner with leading businesses, governments and financial institutions to accelerate their route to Net Zero. As a partner in the ISS Programme, they have led delivery of support packages on business and commercial modelling.

Ipsos

An innovative leader in market research, delivering reliable information and understanding of society, markets and people. As a partner in the ISS Programme, Ipsos led on the primary consumer research elements of Phase 1.

2.4 Approach for this report

This final report offers key insights from across the ISS programme. Emphasis is placed on the findings and conclusions from Phase 2, with the aim of offering consumer, business and commercial, as well as policy implications following completion of the innovator solution trials.

A brief summary of the research conducted during Phase 1 is provided (Section 3). Next, summaries of the innovative solution trials are provided in Section 4, including aims, approach, key findings and conclusions, as well as next steps and recommendations. The programme-level insights are introduced from Section 5 (Programme insights), including implications and recommendations (Section 6), and conclusions and programme lessons (Section 7).

3. Phase 1: Background research summary

4. Phase 2: Innovation project summaries

5. Programme insights

6. Implications and recommendations

7. Conclusions and programme lessons

3. Phase 1: Background research summary

This section summarises the key learnings and outcomes from Phase 1 of the ISS programme, covering the primary qualitative and quantitative research.

3.1 Approach

The primary research undertaken during Phase 1 was geared towards sizing and understanding the consumer groups at most risk of being excluded from a future energy system, and exploring the barriers they face. Quantitative and qualitative techniques were employed to meet this aim.

The quantitative research drew upon survey methodology with a (weighted[8]) nationally representative sample (n = 3080). A subsequent, 'boost' sample aimed to target LIV consumers, with 3122 respondents completing a screening questionnaire, from which 1814 qualified as LIV[9] and proceeded to the full survey. This resulted in two analysable samples: a total sample (n = 6202), who completed the screening questions, and the main sample (n = 4894), who completed the full survey. Meanwhile, the qualitative research included three deliberative workshops with a single group of consumers (n = 33), and one-to-one in-depth interviews (n = 17) which targeted the most vulnerable consumers (total qualitative research N = 50).

Consumers were asked to self-report on the following general questions:

- sociodemographic background, such as gender, age, ethnicity and income;
- household status, such as tenure, urbanity, property type, main heating source and occupancy;
- current energy behaviour, including the prevalence of smart and low carbon technologies (LCTs), and energy-switching behaviour;
- intended future energy behaviour, including uptake of new LCTs and/or smart technologies, and of flexible energy services;
- energy needs, such as domestic requirements;
- barriers and facilitators to engaging in future smart energy solutions.

[8] Data were weighted according to Office for National Statistics population estimates, based on gender, age region, education, ethnicity, index of multiple deprivation, and number of adults in households to ensure representativeness.

[9] Based on households with someone who has a disability, has a health condition made worse by the cold, or relies upon medical equipment that uses electricity; renters (private or social); or households on low incomes.

3.2 Findings

The main findings of the Phase 1 research have been summarised below. These include the groups at most risk of future energy exclusion, consumer needs as related to future energy, and the key barriers and enablers for LIV consumers of participating in a smart, flexible energy system.

3.2.1 Consumers at risk of exclusion from Smart Future Energy

Based on survey responses to questions about current and future smart technology ownership, statistical significance testing was implemented to identify those household characteristics most indicative of being at risk of exclusion from a future energy system. These are displayed in Table 1, along with other captured sociodemographic data.

As shown in Table 1, there were seven groups found to be significantly more likely to be at risk of being locked out of a future, smart energy system, compared to other sociodemographic groups, based on self-reported current and intended future energy behaviours. Overall, 69% of the main sample belonged to at least one of the seven groups more likely to be locked out.

It is important to note that belonging to one of these groups confers only an increased likelihood of being locked out, according to the present survey work. Clearly, there will be some consumers belonging to these groups who are unlikely to be locked out, just as there may be other consumers not falling into these categories who are. Similarly, the groups found not to be at increased risk of being locked out (e.g. living in a rural area) do not necessarily have no risk; however, their statistical risk was not found to be significantly different from the general population within this research.

Consumer groups	At heightened risk of being 'locked out'	Proportion of sample
Households in receipt of any benefit[a]	Yes*	38%
Tenants (private and social)[a]	Yes*	22%
People over the age of 65[a]	Yes*	24%
Low-income households (<£26,000 annually)[a]	Yes*	23%
Living alone[b]	Yes*	16%
Living in flats and maisonettes[b]	Yes*	16%
Those with pre-payment meters[b]	Yes*	8%
Households where at least one resident has an ongoing illness or disability[ac]	No	39%
Living in a rural are[aa]	No	21%
Ethnic minorities[a]	No	11%

Table 1. Consumers at risk of being excluded from a smart, future energy system.

Notes:
* Indicates group significantly more likely to be 'locked out' of a future, smart energy system based on survey responses ($p<.05$).
a Based on a sample size of n=6202.
b Based on a sample size of n=4894.
c Includes households where at least one resident: has a long-standing illness or disability or a health condition made worse by the cold, or relies on medical equipment that uses electricity.

Whilst the identified at-risk groups corroborated prior understanding of LIV consumers, an important observation was that single occupancy households, seldom previously considered within vulnerability research and practice, also face barriers to participating in future smart energy. Interestingly, households where at least one resident had an ongoing illness or disability were not found to be significantly more likely to be locked out. Nevertheless, this group was included as part of the focus of Phase 2 due to its pertinence in previous research. There are also reasons to believe this group may have barriers to engagement not covered in the present survey, such as accessibility difficulties.

Notably, there was substantial overlap across consumer groups. Considering the seven groups significantly more likely to be locked out, 22% of the main sample belonged to just one of those groups, 24% two groups, 13% three groups and 7% four groups. Future research could consider the relative risk ratios for households which belong to multiple at-risk groups to understand how these factors might compound the likelihood of being locked out. Additionally, there may be further sociodemographic factors and interactions that may place individuals and households at-risk, not considered here.

3.2.2 Consumer needs

Qualitative exploration of LIV consumers' energy needs, barriers and enablers to smart energy solutions showed considerable consistency across the LIV groups identified in the survey. There were, however, differences in how groups prioritised needs and the extent to which they were impacted by barriers. The energy needs commonly identified across consumers were as follows:

- meeting basic domestic requirements such as cooking, cleaning and being warm;
- being able to relax and comfortably enjoy their home, for example by watching TV or enjoying a hot bath;
- affordability (of meeting basic energy needs);
- simple to understand and use services that put the consumer in control.

3.2.3 Barriers and enablers for LIV consumers to participating in a smart energy system

Some of the key barriers to engagement with smart energy solutions for LIV consumers, as identified through the qualitative work, were as follows:

- Struggling to identify the benefits of smart energy solutions leaves consumers believing those solutions may not be worthwhile for them.
- Struggling to access easy-to-understand and trustworthy information about smart solutions leaves consumers unable to confidently decide if a solution is right for them.
- Upfront capital costs are the primary barrier to uptake of higher cost smart technologies (e.g. EVs, heat pumps and solar PV), and a main barrier to lower cost smart technology (e.g. smart heating controls and smart plugs).
- Perceived inability to change behaviour particularly limits the appeal of flexible services for those with young children, those with medical equipment that uses energy and those who are at home a lot.
- Physical circumstances which remove consumers' agency to make changes and adopt services, such as amongst tenants. New services for this group may be needed which also target landlords.
- Perceived inability to change behaviour particularly limits the appeal of flexible services for those with young children, those with medical equipment that uses energy and those who are at home a lot.
- Physical circumstances which remove consumers' agency to make changes and adopt services, such as amongst tenants. New services for this group may be needed which also target landlords.

The key facilitators for LIV consumers to participate in a smart, flexible energy system include:

- Demonstrating benefits to LIV consumers resulted in them being more willing to purchase or use smart solutions. A significant benefit that participants were looking for was whether these could save them money (relative to the overall cost of the products or service), and how smart solutions can enable better or more convenient control of their energy usage.
- Accessing clear and trustworthy information: participants wanted to have access to information that clearly spelled out their options and was from what they saw as a reliable source.
- Support for upfront costs: participants highlighted that they would need support in the form of a grant or loan to afford smart energy products. Other business models and payment structures that reduce the upfront costs could also overcome this barrier, perhaps spreading costs over a contract term, or sharing costs through communal equipment.
- Support consumers in shifting their energy use: either through alerts, automation and/or education, which may facilitate engagement with flexible energy services.

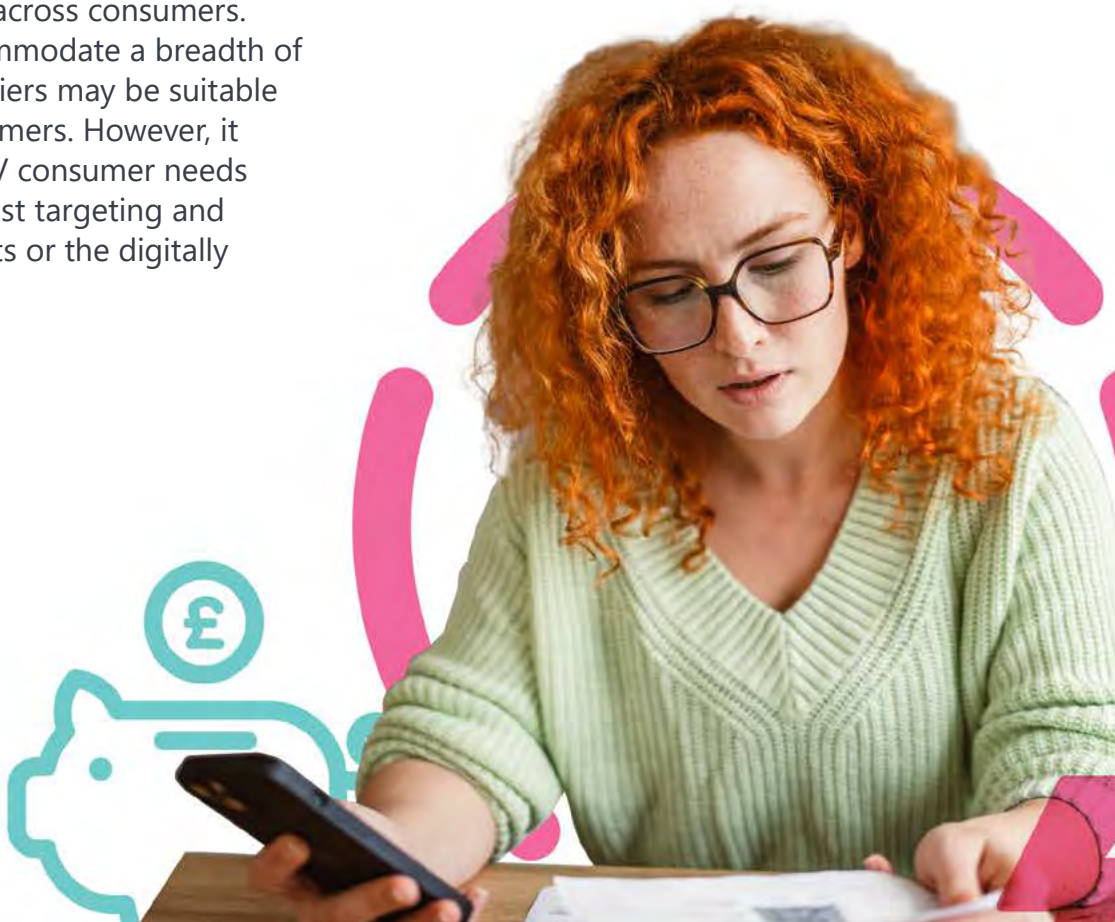
3.3 Phase 1 conclusions

The quantitative and qualitative research conducted in Phase 1 highlighted several groups of consumers deemed to be at most risk of exclusion from a future, smart energy system, and pointed to some of the energy needs and barriers faced by consumers.

The identification of several at-risk groups demonstrated that there are many ways that consumers can be left behind within the energy system. This research has shed light on the barriers and facilitators for these consumers. Further research may uncover additional groups and barriers to participation in smart, future energy. However, through qualitative exploration, those with disabilities and income-related vulnerabilities (i.e. low income or in receipt of benefits) appeared to represent a substantial proportion of consumers having barriers to participation.

We observed consistency across at-risk consumers, and, to a lesser extent, across all consumers, in terms of their difficulties participating in a future energy system. That is, many of the barriers to engaging in future energy may be common across consumers. Thus, solutions that accommodate a breadth of consumer needs and barriers may be suitable for a wide range of consumers. However, it seems likely that some LIV consumer needs may require more specialist targeting and protection, such as tenants or the digitally excluded.

Phase 1 helped to build upon prior research and informed the focus of Phase 2. It is important to note that, whilst Phase 1 corroborated prior research on vulnerable consumers, with the critical addition of the sole occupancy group, the focus of Phase 1 was on identifying all those groups likely to be excluded in a future energy system. This diverges from previous definitions of vulnerability in the energy sector, which focus on specific difficulties and concerns, such as individuals affected by cold homes or medically dependent on electricity. Thus, the LIV conceptualisation employed in the present research is perhaps broader than typically used, which is reflected in the size of the estimated at-risk consumer group (69%). Thus, aligning with the aims of the ISS programme, the term 'LIV consumers' is used to describe all those 'locked out' consumers. Future work could continue to advance definitions of LIV consumers to reflect the needs and barriers of this group. Phase 2 subsequently focused primarily on LIV consumers identified during Phase 1.



4. Phase 2: Innovation project summaries

This section provides a brief overview of the approach and outcomes for each of the four innovative solutions trialled during Phase 2 of the programme. A summary of work covering the consumer research, business and commercial modelling, and policy and regulations is provided for each solution. This is intended to provide the reader with sufficient contextual information about each solution so as to facilitate interpretation of the findings across the programme. Subsequent discussion of the higher-level conclusions and insights from the programme is provided in Section 5.

4.1 Innovative solutions

The four projects selected and developed for Phase 2 of the ISS programme demonstrated the potential to improve access, purchase and use (see Figure 2) of smart energy, such as via increased participation in dynamic energy flexibility, adoption of relevant technologies, and optimisation of how much energy is being used in low-income and vulnerable households.

The solutions aimed to target a range of LIV consumers, especially those found to be at most risk of being excluded from a future energy system as established in Phase 1. The four solutions consisted broadly of service-based (Changeworks, Repowering) and technology-based (equiwatt, Homely) propositions.

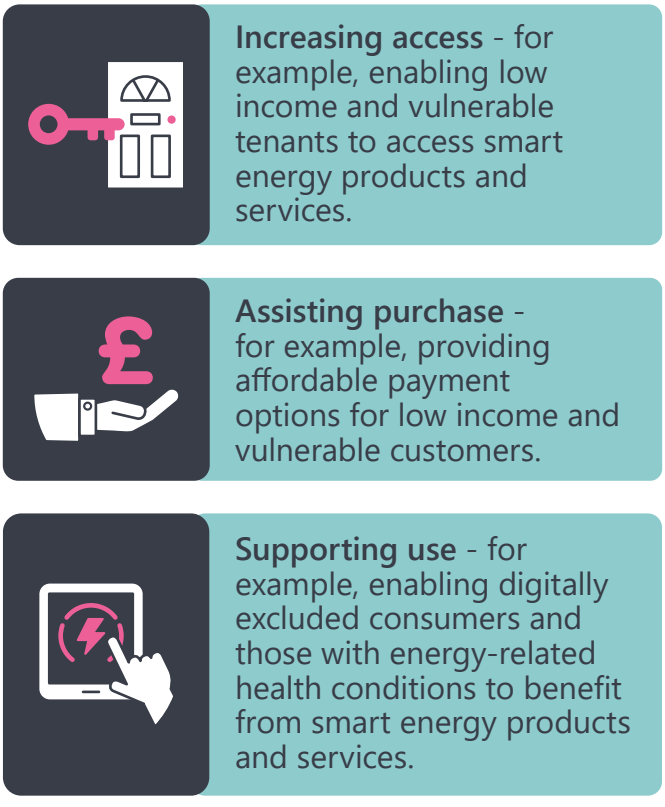


Figure 2. Modes of consumer engagement in smart energy

4.1.1 Development and trialling approach

The general approach adopted to develop the innovative solutions during Phase 2 is shown in Figure 3. Each solution was developed over a period of up to 12 months. An initial stream of research, Round 1, comprised the identification, development and testing of risky assumptions[10] for each solution; a second stream, Round 2, involved the rollout of the solution with LIV consumers. Across Phase 2, business and commercial modelling work, as well as policy and regulations research, was also carried out. This also included value proposition design, referring to the commercial feasibility of the solution.

A range of LIV consumers were actively engaged in in-depth research as part of the research (n = 85), along with a group of experts by experience (n = 11), themselves LIV consumers, who supported project teams in the development of the solutions. Additionally, a large number of total consumers (N = 20,276) participated across research trials (largely populated by those in the substantive equiwatt trial) but did not partake in in-depth research. The policy and regulatory, and business and commercial modelling research, incorporated interviews with relevant stakeholders (N = 36), case study analysis, desk research, and innovators' insights.

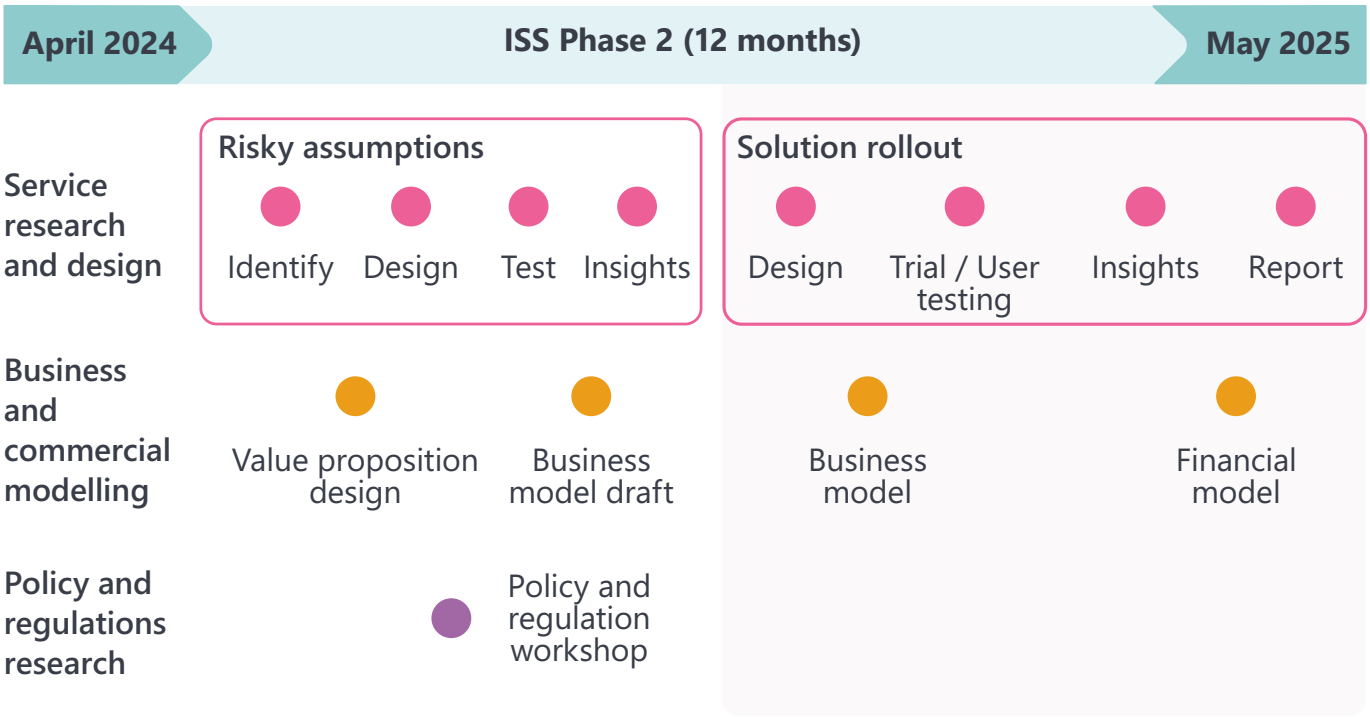


Figure 3. General approach to developing innovative solutions.

[10] We prioritised research which investigated uncertainties (risky assumptions) rather than exploring the general problem space to maximise the impact of the research on progressing the innovative solutions.

4.2 Changeworks: Smart tenant smart home

Changeworks is developing a new service to support social landlords in retrofitting their properties with smart energy systems.

Registered social landlords (RSLs) are working to decarbonise their housing stock, which is usually achieved through a combination of energy demand reduction and electrification of heating and hot water. However, electrification without smart controls could leave tenants vulnerable to expensive peak electricity prices and fail to maximise the use of cleaner, cheaper renewable energy when it is available, as well as contributing to local grid constraints at times of high demand. Furthermore, RSLs recognise that they cannot rely on grant funding alone to upgrade all of their properties and are seeking alternative ways to finance retrofit at scale. Smart energy systems can help to unlock new revenue streams or improve existing revenue streams that could be used to facilitate payback of the capital cost of the retrofit, e.g. energy bill savings, solar energy sales, or flexibility revenue.

Changeworks is addressing these challenges by developing a service for social housing that will plan, finance, install, and operate a complete package of measures including fabric upgrades, on-site renewable generation and smart energy systems. Changeworks has partnered with technology provider Scene Connect, who have developed a platform (ZUoS) to offer automated control and optimise household energy usage. The ZUoS system enables individual components of a low carbon energy system (PV, batteries, electrified heating and smart appliances) to work together to shape household energy supply and demand in a way that reduces energy consumption and costs without compromising comfort. Most importantly, tenants will not need technical knowledge to operate the ZUoS system, making it accessible to tenants who may struggle with smart technology or do not have a confident knowledge of low carbon technologies.

4.2.1 Aims

Changeworks' proposed solution was at a very early, conceptual stage at the beginning of the project. The research therefore aimed to shape the service and the customer journey through co-design with social housing tenants, to ensure that the service meets their needs as well as the needs of their landlords. The consumer research and co-design activities were focused on social housing tenants in Scotland, which is Changeworks' priority target market.

The research also aimed to develop and validate a suitable business and commercial model for the proposed service. In particular, Changeworks wished to explore various options for structuring the service, such as special purpose vehicles, and any policy or regulatory barriers to the proposed operating model. A key requirement was to develop a model that ensured the service would be affordable for tenants and provide them with a saving on their overall energy bill, whilst still being commercially viable and able to attract the finance required to fund the property upgrades. The research aimed to test the investability of the model by obtaining feedback from suitable finance providers (e.g. investment banks, social impact fund managers).

Finally, the research aimed to segment Changeworks' target market (social housing in Scotland) and select a particular housing archetype to model the energy flows of the proposed system, and input to the financial model.

4.2.2 Approach

Co-creating and testing service proposition with end users

The co-creation and proposition development activities delivered by TPX Impact were divided into two rounds. The first round was aimed at developing and testing high-level concepts and risky assumptions, which informed the initial design of the service, whilst the second was aimed at testing a minimum viable service design and proposed options for the service.

Each round of proposition development began with a co-design workshop between the project partners and Experts by Experience (individuals who had participated in the ISS Phase 1 research and had lived experience of one or more vulnerabilities), followed by participatory research to test the proposition with social housing tenants in Scotland. The co-design workshops allowed ideas for the service to be tested and developed with feedback from LIV consumers in a low risk setting, with insights from the Experts by Experience being used to inform a shortlist of assumptions or scenarios that required further investigation with a larger sample size.

In the first round of research, assumptions were tested through semi-structured interviews with social housing tenants, which were held in a local community space at times that suited the interviewees. Nine tenants responded to the invitation and six successfully attended the interviews. Three prototypes were used to illustrate aspects of the service and prompt feedback from the tenants:

- a mock letter from a fictional housing association, to show how tenants might be informed about a proposed installation of smart systems in their building;
- a leaflet explaining how the smart system works;
- a mock energy bill from a fictional energy services company, to show how tenants might be billed for the service.

Insights from the first round of research were synthesised and evaluated in a workshop with the Experts by Experience to inform a minimum viable service design.

In the second round of research, further assumptions and scenarios for the minimum viable service were tested through a) a deliberative workshop held with social housing tenants in a community space in Edinburgh, and b) several semi-structured interviews with four individuals receiving support from Changeworks' Affordable Warmth programme.[11] Twenty one tenants responded to the invitation for the deliberative workshop and 20 successfully attended.

Research participants were recruited by liaising with several registered social landlords based around Edinburgh, who sent comms to their tenants inviting them to participate in the research. Uptake for the first round of research was relatively low (nine responses), due to the very short timeframe for design and approval of the prototypes and recruitment comms, getting RSLs on board and sending out comms, which meant that comms were sent out less than a couple of weeks in advance

[11] Affordable Warmth is a service that provides advice and support to households who are in fuel poverty and fuel debt, helping them to reduce energy costs, make financial savings and resolve billing issues (https://www.changeworks.org.uk/b/affordable-warmth-services/)

of the interview dates. However, in the second round of research, more time was ringfenced for recruitment, and RSLs were already on-boarded so were able to send comms out to their tenants more quickly and well in advance of the workshop date. The participant incentives were also increased. These factors resulted in much higher uptake for the deliberative workshop (20 participants).

The participants represented a range of the LIV segments identified in Phase 1 of ISS. However, in the second round of research a concerted effort was made to include the views of those in fuel poverty, to ensure that potential payment mechanisms for the service would meet their needs. This was achieved by supplementing the recruitment of participants from fuel poor households receiving support from Changeworks' Affordable Warmth programme.

Insights from the research were obtained through affinity mapping and thematic analysis of feedback from the interviews and workshop.

Business and commercial model

Carbon Trust led a comprehensive programme of business model design, testing and validation, including an exploration of potential policy or regulatory barriers for the proposed service.

The business model design activities included a business model canvassing exercise to define all aspects of the proposed business model, a definition of the value proposition for RSLs and tenants, and identification of critical assumptions that could cause the business model to fail if invalidated. These assumptions were prioritised and tested through a combination of desk-based research and interviews with relevant stakeholders (e.g. social housing experts, RSLs, energy suppliers). The business model design was iterated based on the results of this research, the consumer research carried out by TPXImpact, and market research carried out by Changeworks.

The final output of the business model design work detailed two potential business model options to take forward for commercial modelling. This comprised building a financial model (carried out by ESC) and validation of assumptions and inputs for the model (carried out by Carbon Trust). Validation of assumptions was again achieved through a combination of desk-based research and stakeholder interviews (e.g. finance providers, insurance providers). Further inputs for the financial model were provided by Changeworks (on capital costs for the system) and by Scene Connect, who carried out modelling of the energy flows and bill savings for tenants of an archetypal four-in-a-block property.

4.2.3 Key findings and conclusions

Consumer

The LIV consumer research highlighted the challenges that may be encountered in engaging and obtaining buy-in from a block of multiple social housing tenants that have different needs, priorities and opinions, with responses varying considerably between individual participants.

For example, when considering how to communicate complex changes to their building and energy systems, some wanted to receive a lot of technical detail about the system while others only wanted a high-level overview; some wanted to be actively involved in influencing the design of the system while others only wanted to be kept informed. Similarly, while some participants had reservations about sharing their energy consumption data at the system design and

feasibility stage, others were open to sharing their energy data as long as they understood what it would be used for and how it would benefit them.

Some consensus did emerge on particular topics, though. For example, most participants were open to having their building upgraded and responded positively to the idea of new heating controls, with a consistently warm home and lower energy bills considered to be important benefits of the service.

However, most participants felt negatively about having to pay for the system, even if they would receive a saving overall - since they did not own the property, they felt that the landlord should pay for upgrades to the building. Participants wanted to ensure that any costs would be distributed fairly and based on actual usage of the system.

Many participants also felt negatively about the idea of not being able to change their energy supplier, even if the tariff was cheaper and billing was simpler. Participants wanted to maintain the ability to choose a supplier and tariff that they deemed to best meet their own individual needs, and to ensure that they were always getting the best deal.

Trust was also an important factor in participants' acceptance of the service. For example, many participants wanted to see evidence that the service would work in practice for households like theirs before signing up. Participants also raised concerns around the reputability of potential partners that might be involved in delivering the service.

Generally, the consumer research highlighted the importance of iteration and testing in order to meet the majority of tenants' needs.

Commercial

Changeworks' market research and segmentation exercise highlighted the importance of considering housing archetypes, while Carbon Trust's research confirmed that taking on additional debt for energy-related upgrades is a barrier for RSLs in the short term.

Financiers, such as impact investors, were interested in the general model but highlighted the need for de-risking. The commercial model also showed that the high cost of borrowing at this moment in time poses a strong challenge to financial viability, and hence some amount of grant funding is essential. The Energy Company Obligation[12] (ECO; the fourth phase, ECO4, of which is currently running) is a viable source of such grant funding.

Feedback suggested that delineating behind-the-meter solar energy as a distinct revenue stream is highly desirable. However, the commercial model showed that the viability of this approach is very dependent on the peak capacity of the solar array, which may be limited by the available roof area of certain housing archetypes.

Policy and regulatory

The policy and regulation research confirmed that RSLs are currently in a challenging financial position and that there is a significant funding gap for energy upgrades in social housing.

Ofgem's consumer protection rules require that domestic customers have the right to switch energy suppliers if they pay for their energy bill directly. This could be a blocker to Energy Services Company (ESCo)-type business models in which the supplier and tariff may be fixed.

4.2.4 Innovator next steps and recommendations

During the project, we were able to complete two rounds of consumer co-creation and business model iteration. Given the early stage that Changeworks' solution started at in this project, we would recommend further development of the business model to incorporate the final findings from the consumer research, and testing the iterated business model once again with social housing tenants to ensure that the service meets their needs.

Recommendations arising from the consumer research for modifying the business model to meet tenants' needs include:

- removing the loan repayment component from the tenant-facing side of the service;
- prioritising tenant access to, and cost savings from, flexible energy;
- keeping the service as simple and familiar as possible for tenants;
- giving tenants the agency to choose what's best for them;
- considering using housing associations as the 'face' of service delivery, to capitalise on tenants' trust in them;
- creating and distributing (e.g. via RSLs) educational content and evidence to build tenants' confidence in the technology and debunk common misconceptions (e.g. around heat pumps).

The desirability of the RSL-facing side of the service should also be validated by seeking feedback on the model from RSLs.

The Catapult is also planning to organise an investor workshop to obtain feedback on the model from several finance providers (in particular, impact investment funds).

Changeworks are already in the process of characterising the legal, resourcing and financial requirements and implications of forming a SPV to deliver the service. They will also need to identify which partners will be needed to deliver the service (in particular, who might be able to deliver at the scale required for the model to be viable) and start establishing understandings with them.

Changeworks should use the commercial model that has been built to determine a suitable number of properties to target for installation, set appropriate price levels, etc. Given the dependence on grant funding revealed in the commercial model, we would also recommend that Changeworks investigate the details of ECO and how this funding could be claimed through the service, and – if the necessary data is available – carry out a segmentation exercise to estimate how many of the target social housing tenants would meet the eligibility criteria for ECO. As part of this investigation, we would recommend speaking to an energy supplier to validate assumptions and try to establish a possible partnership. Other possible sources of grant funding should also be explored.

Once the final service model is at a suitable readiness level, we would recommend that Changeworks seek funding and partners for a multi-property pilot project to demonstrate whether the service works in practice – in particular the finance repayment model – and whether it delivers benefits for all residents and stakeholders.

4.3 equiwatt

equiwatt proposed the creation of a user-friendly platform that engages LIV consumers in smart, flexible energy systems. This platform would allow consumers to earn financial rewards by participating in demand flexibility events, which involves reducing energy consumption during peak times. The equiwatt platform aims to eliminate common barriers like lack of awareness, complexity and cost, making it easier for LIV consumers to participate.

equiwatt therefore developed an app-based service to enable customers to easily participate in demand reduction events (e.g. the Demand Flexibility Service [DFS] run by the National Energy System Operator [NESO]) and earn financial rewards. This was primarily done in partnership with ScottishPower, but other energy suppliers would be compatible. This platform operates currently with 75,000 members, and equiwatt plans to scale to over 1 million users. For this project, equiwatt proposed to develop and enhance its app to make it more accessible for LIV consumers, particularly those who may struggle with technology.

4.3.1 Aims

The main aim of this project was to understand, through co-design and research activities, how equiwatt can best support, and offer value to, LIV consumers. Assessing if current market conditions can enable products like equiwatt's Power Saver app in meeting LIV consumer needs, the project looked to identify barriers, and surface opportunities, leading to better alignment of consumer needs to flexibility products and services.

Providing LIV consumers with a more meaningful and tangible experience may increase engagement, participation, and education within the flexible energy space. Developing an equitable, supportive, engaging solution for consumers with a diverse set of needs could go a long way in ensuring that consumers don't get left behind in the flexible energy transition.

Identifying barriers to access is critical in opening up flexibility as a whole, and by addressing some of these intrinsic issues, this project not only served to benefit equiwatt, but to support further innovation in flexibility, both currently and in the future.

Commercial insights, along with assessing policy and regulatory frameworks, provided wider market understanding as to whether opportunities exist, or if innovation is limited. This adds to the breadth of research in how best to meet LIV consumer needs and articulate the wider potential of the future of flexibility products and services.

The problem

Currently the equiwatt Power Saver app is designed for the mass market and is not being well used by LIV households.

Powering down may not be possible or desirable to many households because:

- they don't know about it;
- they lack digital confidence;
- they don't have a smart meter;
- they may already use very little energy to keep their bills low.

Given that the Demand Flexibility Service model rewards people for the total electricity (kWh) they save during events, LIV households who are currently under heating their homes and consuming less energy already may stand little to gain from using the app/service.

There were two main strands of focus – the service model and service proposition, matched against consumer needs, business needs, and market needs.

The service proposition development aims were to:

- test the current value proposition and alternatives;
- co-design a set of 'system interventions' with key energy system stakeholders to test alternative demand flex concepts with LIV consumers through qualitative interviews;
- test how proposition framing impacts users' motivation to participate and engage;
- obtain qualitative data through survey/ interview questions to learn how LIV consumers expect to participate and be rewarded for flexing their energy usage.

The service model development aims were to:

- understand if LIV consumers could use an improved app-based service with phone support;
- design and deliver a new service model with improved content and SMS notifications that uses energy supplier customer service infrastructure (provided by ScottishPower) to reach LIV consumers and provide offline support;
- market the service to 20,000 LIV consumers, measuring uptake and drop off throughout the service journey;
- conduct surveys and qualitative interviews with a mix of those who chose to use the service and those who didn't to understand what stopped them.

The consumer needs focused on:

- providing financial support and tools for households, especially LIV consumers disproportionately affected by energy costs;
- accessible communication and actionable insights to educate and encourage energy-efficient behaviours;
- providing access to an equitable, inclusive, and supportive service to participate in, and benefit from flexible energy.

The business needs focused on:

- enhancing engagement with LIV consumers by addressing barriers and instilling trust;
- supporting the development of innovative flexible energy products and services within the bounds of current policies and regulations;
- clarity of the as-is and future state of flexibility to open up opportunity for business scaling through new routes to market.

The market needs focused on:

- supporting grid stability and decarbonisation by shifting energy consumption patterns;
- identifying policy gaps that may not support innovation in flexible energy services;

- aligning with the current policy and regulatory landscape to expand participation in demand-side response (DSR) initiatives;
- identifying how proposed changes in policy and regulations may support the development of flexible energy services and products.

4.3.2 Approach

A human-centred co-design approach was adopted for development and trialling of the equiwatt solution with support from their partner ScottishPower. Design and research activities led by TPXImpact were split into different phases: 'Testing riskiest assumptions', 'Designing a minimum viable service', and 'Testing a minimum viable service'. These phases contained specific design and research activities and saw the inclusion of two 'Experts by Experience' within key workshops. Their participation in the design process helped the delivery team keep design outputs grounded and relative to the identified user groups.

Testing riskiest assumptions

The project began with an exercise in mapping the end-to-end journey of the existing eqiwatt solution – the Power Saver App – which was originally designed for the mass market. Helping the team identify pain points and opportunities set the basis for the next step of co-design: a prototyping workshop.

The prototyping workshop looked to identify how the service could be improved to provide greater value for LIV consumers, and saw input from key stakeholders, including Experts by Experience to identify the biggest risks to test with LIV consumers.

After the session TPXImpact further developed the prototypes and developed a plan to test the high-level concepts with eight households.

Round 1 research: Interviews and testing

TPXImpact conducted in-home and online interviews with LIV consumers to understand more about their energy habits, experiences with automation, and what type of appliances they have in the home. These insights helped strengthen understanding of the needs of LIV consumers when managing their energy.

The prototype was also tested with the consumers to further knowledge about how the service proposition was presented to them and how they may interact with such a tool to help them participate in demand flexibility events.

Following this, TPXImpact led a synthesis workshop, which saw participation by the innovator and Experts by Experience to help establish next steps in designing and defining a minimum viable service to conduct the second round of research through trialling.

Designing a minimum viable service

This phase of the process saw the team narrow down focus for the trial. Feasibility scoping with the delivery team helped prioritise areas to test which were, 1: improved content and onboarding, and 2: improved help and support for LIV consumers. After alignment was agreed, the prototypes were developed further, along with the trial testing plan.

Round 2 research: Testing a minimum viable service

The app was trialled through three live DFS events with ScottishPower customers matching the LIV criteria defined in ISS Phase 1. TPXImpact contacted 19,122 LIV consumers by email and 878 by letter and invited them to download the Power Saver app. Then they measured uptake and engagement with the service which saw 220 (1%) eligible users.

A ScottishPower branded version of the minimum viable service featuring improvements to content and onboarding, along with improved offline support mechanisms (supported by ScottishPower's customer service team) were tested at scale. Messages emphasising financial rewards were compared to those highlighting environmental benefits to determine which type of framing most effectively motivated LIV consumers to participate in demand flexibility events. Email open rates for both messaging options were almost the same: rewards-focused messaging (42%), environmentally focused messaging (41%).

These trials were supported by additional research (a short survey and 11 30-minute semi-structured user research interviews) to further understand trial participation, adding valuable qualitative insight to the trial's quantitative data. There were 82 responses to the survey, which was sent to a selection of participants, with 57% having a disability or long-term health issue, 64% having a household income of below £30,000, and 37% using prepayment meters. Interview participation saw 73% with a disability or long-term health issue. Overall, the research and design approach was highly collaborative and gave a voice to real people in the problem space, whilst understanding the innovator's core business needs.

Assessing consumer needs, service touch points, technical constraints, and data considerations behind the MVS defined the working scope and feasibility, which established key priorities for the trial. Synthesis workshops were also key in communicating the direction of travel, and helped maintain momentum and alignment throughout the design process.

This consumer-focused workstream tied into the work from Carbon Trust, who provided insight and recommendations around appropriate business and commercial models, and a broader assessment of how the policy and regulatory landscape could inhibit or support innovators like equiwatt in delivering flexible energy products and services.

4.3.3 Key findings and conclusions

Consumer

While financial rewards (issued separately to bills) are important to LIV consumers and a key motivator, reducing their energy bills is still the highest priority. This was mentioned by 66% of survey respondents and was highlighted frequently in user interviews. Some users also expected an app of this nature to provide energy-saving tips to help them better manage their energy usage at home.

In connection to this, rewards-focused messaging motivated participants to reduce their energy usage. Participants who received rewards-focused messaging reduced their energy use more during Power Saver events than people who received the environmental messaging. The rewards-focused group's overall energy consumption during events was 4.7% less on average compared to those in the environmental group.

This said, receiving reward or environmental-focused notification messages post-download had no significant impact on whether participants opted into events. This tells us that they're motivated to participate irrespective of the messaging they receive once using the app. However, we can assume that rewards-focused messaging may encourage them to decrease their energy consumption more significantly.

The research also highlighted that LIV participants may be more motivated to save energy than average consumers because they ultimately want to save money. Trial participants who received rewards messaging were more likely to deliver energy savings than the control group or environmental group (68% vs 63%).

There is strong indication that LIV consumers are cost-conscious, so they may be more motivated to try to reduce their energy use. However, as new users, the trial participants may have been more engaged with the app than existing customers.

People who use less energy in general will struggle to benefit financially from demand flexibility events. Because LIV consumers want to save money on energy, offering free or cheaper electricity during off-peak times could be a valuable incentive to shift energy use and save money – their priority when engaging in flexibility. Yet, low energy users are at a significant disadvantage when it comes to their ability to financially benefit from demand flexibility events. There was also an expectation to be rewarded with money off their next energy bill or quick credit on their prepayment meter. Having to wait a long time to earn rewards may be a barrier. Lower energy usage coupled with a delay in receiving rewards causes friction, potentially leading to less engagement and lower app retention rates.

Low energy users may struggle to reduce their energy enough to see timely financial rewards. Flat rewards may encourage them to take part in demand flexibility events, because they might feel that they would be rewarded for their efforts to reduce their energy consumption despite their low usage.

Through the research and design process the improved app content and interface has made it easier to use for LIV consumers who are already digitally confident, but barriers to participation still exist. Most survey respondents thought it was easy or very easy to set up the app (81%) and participate in events (89%). But only 1% of trial participants who were invited to take part became Power Saver users. Improving usability doesn't look to be enough to overcome wider barriers for LIV consumers.

Barriers may include not having a smartphone or WiFi, lack of confidence with technology, or having to use energy at certain times, for example, when carers are visiting. Further research could help understand the low participation rate observed and identify further opportunities to include harder to reach consumers and meet niche needs.

Conclusions

Rewarding LIV consumers quickly and fairly is important for engagement and participation in demand flexibility. Ensuring equitable access to energy-savings for consumers requires addressing multiple barriers, including digital exclusion, affordability, and trust. Many LIV households lack the digital confidence, smart devices, or internet access required for app-based participation, highlighting the need for offline solutions and tailored financial support. Engaging with LIV consumers remains a challenge for innovators, as traditional flexibility incentives often favour higher energy users.

The key consumer findings from the research highlighted some significant barriers for LIV consumers. These can be broken down into three main areas: access, engagement, and motivation. There are also further considerations around marketing and communication, along with a look at how policy and regulatory insights tie into some of these core themes.

Access

- Many LIV consumers lack digital confidence. Requiring app-based participation excludes those who cannot navigate apps, leading to inequitable access to energy-saving programmes. Offline options and hands-on support are essential.
- The cost of automation technologies is prohibitive for LIV consumers. Without affordable automation options, many LIV households cannot fully participate in demand flexibility programmes.
- Smart device costs are a financial barrier for LIV consumers. Without subsidies or funding, many LIV consumers will remain excluded from benefits offered by smart home technologies.
- LIV consumers may not own smartphones or have WiFi access. Services dependent on mobile apps create systemic barriers, excluding some of the most vulnerable households. Text-based or offline solutions can mitigate this.
- Energy-saving services often assume a baseline level of digital skills. Excluding digital skill support alienates a large subset of LIV consumers. Solutions need to integrate educational components and customer support.
- Some LIV consumers distrust smart meters or can't access them due to energy debt. Mistrust and logistical challenges could hinder adoption of demand flexibility programmes. Building trust and addressing energy debt barriers is crucial. Consumers want control.
- Caring responsibilities and rigid routines make power shifting harder for some LIV consumers. Flexibility in scheduling and tailored solutions for specific household needs (e.g. carers) are required to increase accessibility.

Engagement

- LIV households often use minimal energy already. Traditional rewards mechanisms based on energy reduction disproportionately benefit higher energy users, leaving LIV consumers feeling excluded or demotivated.
- Low energy usage results in smaller rewards. LIV consumers with low consumption may disengage if they perceive rewards as unattainable or not worth the effort.
- Many LIV households expect immediate practical benefits from participation. Services must clearly demonstrate tangible short-term savings to overcome scepticism.
- Routine 'sticklers' see little value in shifting energy use. In the absence of significant financial or convenience benefits, these consumers may not engage at all.
- Delayed rewards discourage participation, especially for prepayment users. Services must deliver rewards promptly to maintain engagement and credibility among financially constrained households.
- Many LIV consumers are wary of participating in services perceived as overly complex. Simplifying participation and clearly explaining steps is critical to overcoming perceived complexity.
- Education is key to protect consumers from the risks flexibility may introduce. For example, turning off lights may introduce heightened risk of accident, or medical equipment might be switched off causing health risks.

Motivation

- Financial incentives motivate LIV consumers more than environmental benefits. Services that highlight environmental benefits over cost savings will struggle to engage LIV consumers effectively.
- Rewards-focused messaging increases engagement. Using messaging that emphasises financial rewards can increase participation but may alienate those who value environmental benefits.
- Environmental messaging alone doesn't significantly influence behaviour. Framing the services could pair environmental goals with cost-saving messaging to maximise impact and align with LIV consumer priorities.
- Services designed for general consumers may unintentionally exclude LIV participants. Tailored services that address specific LIV needs (e.g. simplified reward structures, low-tech solutions) are necessary to achieve equitable outcomes.
- LIV consumers may stop participating if they see no immediate benefit. Services should balance long-term rewards with immediate incentives to sustain engagement and avoid drop-offs.

Marketing and communications

- App notifications are effective for some, but many LIV consumers prefer SMS communication. Solely app-based notifications exclude consumers who rely on simpler technology, which could reduce overall engagement.

- Marketing emails led to low app download rates (1%). Email-based recruitment alone is ineffective for LIV consumers. Diversifying outreach channels including community events or postal mail could support digitally excluded consumers.

Commercial

This research has highlighted strong potential in reducing energy costs and improving access to and participation in flexibility services. However, ensuring sustained engagement and participation remains a challenge. The findings highlight the importance of designing more tailored incentives and intuitive rewards structures, simplifying participation processes, and ensuring better integration with existing support mechanisms to maximise impact.

A key commercial challenge for innovators will be in securing long-term funding and regulatory support. Whilst flexibility markets are growing, the benefits for LIV consumers are not always prioritised or represented in mainstream tariffs. Innovators could work closely with policymakers and funding bodies to help shape more inclusive market mechanisms that recognise the social value of flexibility for LIV households. Additionally, partnerships with energy suppliers and local authorities could enhance reach and effectiveness, ensuring that LIV consumers are not left behind in the transition to a smarter, more flexible energy system.

We recommend:

- Developing targeted engagement strategies: Implement outreach initiatives specifically designed for LIV consumers, ensuring accessibility and trust-building through tailored messaging and support.
- Simplifying user experience: Reduce barriers to participation by improving the user experience, integration of technology, and minimising effort required from consumers to engage with flexibility.
- Aligning with policy and funding opportunities: Collaborate with regulators, funding bodies, and energy market stakeholders to secure financial support and regulatory support for LIV-specific flexibility solutions.
- Strengthening partnerships: Work with energy suppliers, local authorities, and community organisations to expand awareness and participation.
- Staying informed: The flexibility landscape is evolving and innovators should keep up to speed on regulatory changes, policy changes, and potential new revenue streams to help in scaling business.

Policy and regulation

The following findings outline how policy and regulatory considerations may impact innovators engaging with LIV consumers, and how current and future policy and regulatory frameworks may either support or hinder accessible and rewarding flexibility services for user groups with very different needs to mass-market consumers:

- Smart meter and data regulations, and access and engagement challenges: Consumers must consent to data access, but many LIV consumers lack digital confidence, distrust smart meters, or struggle with energy debt. Without automation or trust-building measures, smart meter data access remains a barrier. Developing offline and low-tech consent mechanisms (e.g. phone/SMS-based opt-ins) could help in building trust through clear, simple messaging on data security.

- National Energy System Operator (NESO) DFS consultation and cost/tech barriers: Simplified metering requirements reduce participation barriers, but smart device and automation costs remain an issue for LIV consumers. Exploring non-tech-dependent participation methods could provide opportunities for innovators.
- Balancing and Settlement Code (BSC) P415 Modification and low energy usage: A change in the Balancing and Settlement Code (a set of rules that regulate the electricity wholesale market in Great Britain) now allows independent aggregators to trade flexibility in wholesale markets before needing to go through energy suppliers. This could enable more opportunities for innovators to develop things like bundled services, promote greater inclusion of LIV consumers, and facilitate the design of innovative products and services. Alternative reward mechanisms could play a role, too, e.g. calculating rewards based on percentage reduction (not kWh reduction) to offer more equitable rewards for low-energy consuming households.
- Market-wide half-hourly settlement (MHHS)[12] and engagement and financial rewards:
- MHHS could enable more granular data that innovators could use to refine and optimise flexibility services. It could support more precise billing and timely rewards, improving consumer confidence and engagement.
- Policy and regulatory gaps in tariffs and LIV consumer needs: Many LIV consumers may be disproportionately affected by generalised approaches. Financial rewards are the primary motivator for LIV consumers, and a lack of tailored financial incentives might limit participation. Considering LIV-specific dynamic pricing models or automated incentives could increase participation and promote equitable flexible energy. Policy or regulation could consider LIV-specific tariffs and incentives.
- GB Energy developments and participation affordability: New initiatives could provide funding, but LIV consumers need direct financial support to afford participation.
- Stacking and automation: DFS can now be stacked with the capacity market, but LIV consumers can struggle with manual participation due to rigid routines and potential digital literacy issues. Automation tools could help consumers with scheduling events and managing flexibility, with more passive participation options.
- Consumer engagement strategies and marketing preferences: Consumer trust is key, but some LIV consumers may prefer SMS over app-based notifications and distrust complex digital services. This means overly relying on apps for engagement may exclude some LIV consumers. Expanding SMS-based engagement and offering simplified offline participation could boost participation.

[12] Electricity suppliers are required to buy enough energy from generators to meet their consumers' needs in each half-hour period, and 'settlement' is the process for determining whether what they bought matched what their customers used. Most domestic and smaller non-domestic consumers are currently settled based on estimates of how much they have used. However, the rollout of smart meters, which record the amount of energy consumed in each half-hour period, means information about customers' actual half-hourly consumption can be used in settlement.

4.3.4 Innovator next steps and recommendations

equiwatt are interested in exploring and expanding further solutions tailored to LIV consumers. Automation and integration of smart appliances are an area of focus for the future, and providing a portfolio of flexibility products and services would help equiwatt scale and have further reach, offering more tailored solutions. There could be potential in integrating the service into future grant schemes, should subsidies become available for LIV consumers, benefitting from support in acquiring and integrating smart tech into the home, promoting flexible energy behaviours.

equiwatt's aspirations are to collaborate and partner with organisations providing potential new routes to market, such as retrofitting services, the smart home energy management sector, and local authorities enabling community engagement. Keeping track of the development of GB Energy could surface additional opportunities for reach.

This programme has highlighted a need for services tailored to LIV consumers. These groups, representing a substantial proportion of UK households, experience many barriers to access, but the way the flexibility market is currently set up can inhibit innovation. Gaps such as no LIV-specific tariffs being available at present, or implications around data and consent mean innovators are somewhat hamstrung by revenue streams and other barriers. Resolving some of these issues could enable growth for businesses operating in the flex market.

There are other areas synonymous with demand flexibility events that should be further researched, such as a wholly offline journey to support the digitally excluded, or development of automation, which could play a significant role for a flexible future, if researched and designed appropriately.

Owing to timescales, we prioritised two areas: improved content and onboarding, and improved offline support. This meant that we focused on a more digital route which excluded some consumers outlined in Phase 1. Additional research could support the findings of the ISS programme, with equiwatt in a great position to explore and trial ideas through their agile development approach. equiwatt could contribute towards testing products and services, consumer research programmes, validation of propositions, and testing future scenarios in the market.

4.4 Homely Energy

Homely has developed a smart optimiser for heat pump control which considers multiple factors like home heat loss, weather conditions and energy tariffs to dynamically adjust flow temperatures. In this way, the Homely smart optimiser can meet residents' desired comfort levels whilst minimising energy usage and costs. Their solution is already available and being used in the able-to-pay market. According to Homely, the smart optimiser can result in cost savings of between 10-25% per year for this market. They are working on features to integrate heat pump optimisation with control of solar photovoltaic, domestic batteries and EV chargers.

4.4.1 Aims

The aim of this project was to help Homely create a custom version of their smart optimisation technology adapted for low-income and vulnerable users, alongside a viable business plan for making it available to those users.

Many LIV consumers live in social housing, and as the sector is decarbonising, they will be increasingly finding themselves living in homes with heat pumps. For the vast majority, manufacturer controllers are installed as standard. There is a risk that these tenants are not getting the best from their new heat pump heating systems due to a lack of understanding of how best to use them, or control options and optimisation. Also, these controllers offer limited or no support to access potential savings through flexibility from specialist heat pump or time of use tariffs.

Social housing providers are keen that tenants get the best outcomes from their new heating systems but have limited capital to invest so would have to be convinced of the benefits and affordability of Homely.

Further, Homely could be incorporated as part of wider energy efficiency programmes which include a heat pump.

Homely were keen to validate their hypothesis that their optimiser could offer better comfort outcomes at lower prices for these consumers, allowing them to take advantage of flexibility. Homely also wanted to explore routes into this market, and understand how their product might need to change in order to do this.

Specifically then, the objectives of this project were to design and trial a minimum viable version of a digital solution and service for social housing tenants to access intelligent control of heat pumps, enabling lower running costs whilst maintaining comfort. The solution needs to be commercially viable, fit with Homely's existing business model and be acceptable to social housing providers and tenants. This included validating the need for and testing an in-home display, as part of a solution that is not WiFi dependent, and which is designed for ease of use, particularly for those less familiar with this type of technology. It also included exploring viable commercial models and financing options to enable access to this solution for the social housing sector, and looking at the relevant policy and regulations landscape.

4.4.2 Approach

To achieve these aims and objectives, we conducted two phases of design work alongside a programme of business and commercial modelling, and policy and regulation analysis. In addition, Homely applied for and received ECO4 accreditation, and are currently developing a working MVS prototype which could be trialled with target consumers.

Design

Phase 1 of the design work was led by TPXImpact and involved working with the project team and Experts by Experience to identify riskiest assumptions about how the Homely optimiser and service for social housing tenants should work, and developing low-fidelity prototypes to explore these with tenants.

Testing took place in the form of semi-structured contextual interviews either online or in people's homes with participants being asked a number of questions about their current heating behaviours, and shown prototype information leaflets and interface designs.

Participants were eight LIV consumers. Five of these had heat pumps, four lived in rented accommodation, six had low or mid-low digital literacy and one had a pre-payment meter.

A process of qualitative analysis was used to extract key findings and themes from the interviews. Some of these key findings were that not all LIV consumers currently programme their heating, many underheat their homes due to cost and a dislike of waste and that therefore many may struggle to trust Homely and let it run their heat pump in the most efficient way. We also confirmed the solution did need to be a physical controller that works without Wi-Fi, and highlighted the need for LIV consumers to have access to phone or face-to-face support to set up and use a system like this.

We workshopped the outcomes of the Round 1 research with Homely and the Experts by Experience to prioritise the user needs to meet, as well as generate possible design solutions to meet these needs. The agreed goal was to create a solution that simplifies control whilst maximising comfort, energy efficiency and cost savings.

Designs were initially created by TPXImpact and iterated based on feedback from the Catapult and Homely.

In Round 2 of the research, we simulated the experience of people getting set up with a controller for a newly installed heat pump. This included testing an installer script, an instruction manual, and an interactive prototype heating controller. An additional version of the heating controller prototype was created including cost information/ suggestions to help explore user needs around this key aspect in more detail.

A total of 16 participants from across the UK took part in this phase of the research and were recruited via a specialist recruitment agency. Ten of these took place online and six in person. These 16 included:

- 6 living in social housing
- 7 aged over 65
- 9 with low digital literacy
- 7 living with health conditions.

During these sessions, participants were read the installer script, provided with the instruction manual for reference if they wanted it, and asked to step through the heat pump set-up journey using the interactive prototype system. After they'd set their initial schedule, they were shown the cost-feedback interface prototypes and examples of real-time behavioural feedback or 'nudges' that the system might present to them at various times whilst the system was in use.

Findings were analysed using a process of qualitative analysis to identify key themes and patterns in the data, and the implications for design of the Homely solution drawn from these through discussion with project partners.

Business and commercial modelling

Alongside the design work, the riskiest assumptions around the business model and value proposition were identified by conducting a gap analysis of Homely's existing understanding of this space. These were validated through desk work and interviews with industry experts, manufacturing partners and installers, and social housing landlords. As Homely already had a comprehensive financial model, support was given to refine the assumptions of the financial model and improve the forecasts and recommendations.

Policy and regulation

Finally, a policy and regulation analysis was carried out to provide Homely with relevant information on policy and regulatory dependencies for their solution, both in terms of future enablers for Homely as well as potential obstructions.

Homely prototype development

Homely conducted some controller prototype development alongside the above research activities. Initially this included exploring options for off-the-shelf in-home controller user interfaces that could be programmed to meet Homely's requirements, alongside solutions for connecting the controller to the internet without relying on consumer wi-fi connections. Further development work to implement an MVS controller, building on project design outcomes that could be used to trial the Homely in-home controller and experience of heating with LIV consumers, began in January and concluded at the end of the project.

4.4.3 Key findings and conclusions

Consumers

Many social housing tenants need to keep costs low, use alternative methods to stay warm and only turn their central heating on and off manually when they need it. In addition, many are currently underheating their homes to manage costs. For all these consumers, clarity and certainty about costs are critical.

For Homely to deliver efficient heating, LIV consumers who aren't currently setting schedules would have to change their behaviour, as schedules are required for this. Preset schedules and temperature recommendations helped people set a heat pump schedule. However, some still reverted to a boiler mindset and set a schedule for when they'd like their heat pump to be on, rather than when they'd like to be warm. Despite advice on how to heat most efficiently with heat pumps, many people still tried to optimise for their precise needs and routines to keep control over costs, since this was perceived as cheaper.

Whilst those with higher digital literacy were confident in using the controller and said they would tweak the settings to meet their needs over time, those with lower digital confidence would need additional, human, support to give them the confidence to set up and get started with their heat pump and controller.

If people are not confident in setting up their controller, or that they have adequate control over their costs, there is a risk they will revert to using their heat pump as they did their gas boiler – just turning it on and off when needed. This could lead to worse heat outcomes and greater costs than their existing gas heating.

Without trialling a working prototype with LIV consumers in their homes, it is difficult to draw strong conclusions. However, most LIV participants we interviewed found the prototype controller interface we developed easy to use.

Business and commercial

Social housing providers would welcome a solution which improves heating outcomes and reduces bills for their tenants as they transition them to heat pumps. They would also welcome support in helping tenants make this transition. To achieve this, tenant engagement would be crucial pre- and post-installation.

Options to monitor the performance of a heat pump remotely and respond proactively to issues and maintenance, would be a great benefit for landlords, such as in improving resident experience.

There was also interest in a solution that could integrate heat pump control and optimisation with other assets in the future, such as solar and battery. Whilst social landlords are still early on in integrating various assets in a single energy portfolio, they can see the potential of such solutions as their assets expand.

Overall, it's critical for innovators to provide clear evidence and data on the benefits and operational cost savings to social housing providers to unlock trust.

Policy and regulations

There is strict government regulation to ensure residents (and not landlords) have sign-off and right to consent (and withdraw consent) from sharing smart meter data, which might impact innovators' access to such data.

Currently, commercial viability in this sector is a challenge for innovators. Grants and incentives only help with lowering upfront costs of heat pumps, not with reducing full ownership costs. There may be additional means of incentivisation through energy suppliers.

This is also an unclear policy space, for example around the credibility of meeting targets for heat pump installations, making it hard for social landlords to prioritise investment in this direction

4.4.4 Innovator next steps and recommendations

The work done through this programme highlights interest from social housing providers in a Homely-like solution, and a real need for support for LIV customers in transitioning to, and effectively using, heat pumps to heat their homes.

However, access to funding for social housing providers for heat pump optimisation is currently limited, though future spending commitments are possible in this area. Homely should consider partnering with heat pump manufacturers and offer Homely and a five-year service package to social housing providers, including installation of both heat pump and Homely, maintenance and access to flexibility services for their tenants. This would allow social housing providers to finance and understand the benefits of Homely.

The commercial and financial modelling work highlights the need to investigate further – in particular to stress test and explore different scenarios for heat pump installers to find and validate routes to market for Homely in this space, e.g. by exploring partnership opportunities with heat pumps manufacturers for bundled installation offerings, interoperability standards, or different pricing models depending on financing deployed.

Critically, Homely still has to show that their optimiser will be used by, and can provide cost savings for, LIV consumers. This will require an in-home trial with LIV consumers of a working Homely system and in-home controller.

The design and commercial work has highlighted the need for this solution to be a full, wrap-around service, including installation alongside a heat pump, servicing and optimisation, and also education and onboarding support for LIV consumers to guide them through the gas boiler to heat pump transition. This education might be facilitated through training and support for social housing resident liaison officers or installers to enable them to provide the required tenant education and support. This will ensure tenants can get the most from Homely to optimise their heat pump and meet their needs. What is clear is that many of these consumers will need access to face-to-face or phone-line support, and Homely should consider how partnerships might work to deliver this support.

We'd recommend that a trial includes the consumer education and onboarding support, and compares the experience of consumers being onboarded with a heat pump and Homely to those undergoing a standard heat pump and controller install.

The design work outputs include a description of LIV user needs for a Homely onboarding journey and controller, as well as example education materials and tested wire-frame user interfaces for the controller. These should be tested as part of a trial. Homely has been given a steer on directions that this could take through the project design process and reporting. Also, some suggestions for pre-set schedules and nudges were tested in the research – these could be further explored and developed as Homely learns about people's heating behaviours to provide guidance to LIV consumers on how to get better comfort outcomes or save on costs through effective use of Homely.

A key observation is that many LIV consumers currently underheat their homes, largely due to concerns about cost. Good design can go some way to giving people control over the heating they get for the cost they can afford. But whilst Homely can make it easier to get good heat outcomes from heat pumps at the lowest possible cost for those outcomes, this lowest possible cost will still be too much for some consumers.

Although not directly tested by this research, an existing capability of Homely is to take advantage of time of use tariffs which could further reduce heating costs. In addition, taking advantage of other technologies such as solar and battery could also bring down costs. Homely currently understands how these can impact the costs of able-to-pay consumers.

This approach could be extended to exploring other ways to mitigate fuel poverty, such as social tariffs or targeted warm home payments informed by actual home heating requirements. As part of the Chameleon Alternative Market for Energy Assessment ('CAMEA') project[13], Homely is already trialling the delivery of a 'Heat as a Service' offer where residents pay a fixed price for heating their home up to a set temperature in exchange for Homely controlling their heat pump to deliver this flexibly and efficiently. A service like this could be offered to LIV consumers at an affordable price.

Modelling or additional trials to understand the potential savings of Homely for LIV consumers with access to these tariffs or technologies could help make the case for Homely and such solutions.

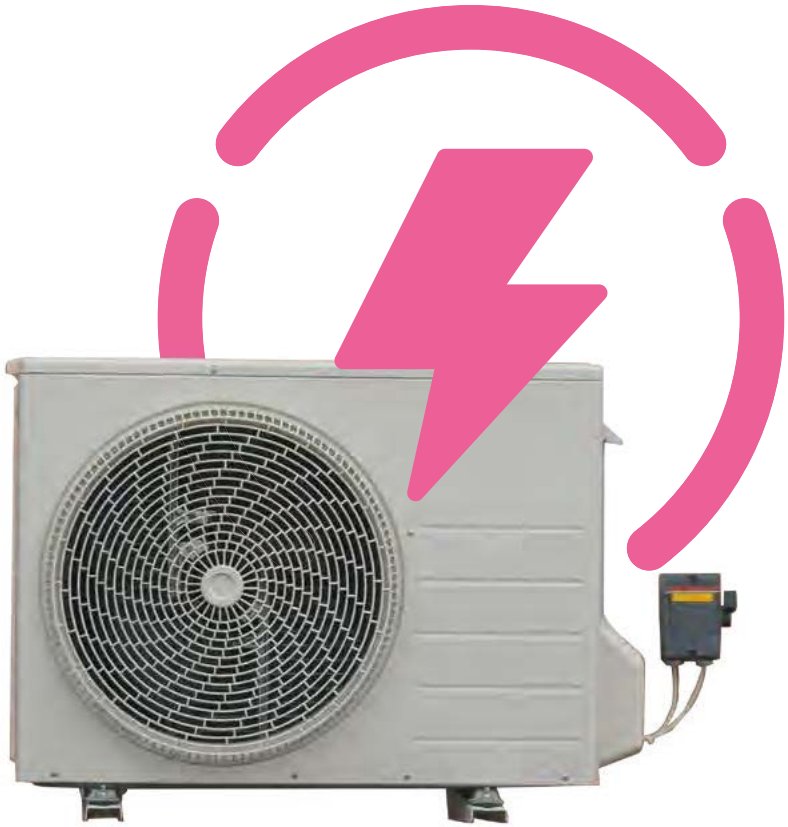
[13] DESNZ (2024b). Alternative Energy Markets Innovation Programme: Phase 2 projects. https://www.gov.uk/government/publications/alternative-energy-markets-innovation-programme-projects/alternative-energy-markets-innovation-programme-phase-1-projects.

In summary, we propose the following next steps for Homely:

- further exploration of original equipment manufacturers and installer partnerships and payment structures to ensure scalable routes to market;
- an in-home trial of an MVS based on project design work with LIV consumers to provide evidence that Homely will be used, improve outcomes and save money for these consumers;
- further design iterations of the MVS to improve choice architecture in the app (implement temperature nudges and preset schedules), and to provide better cost estimates and cost savings support;
- modelling of Homely cost savings for consumers in fuel poverty – considered against current gas heating, a standard heat pump installation without an optimiser, and potentially different future scenarios, e.g. trial tariffs.

We also feel that there are other things which could facilitate the solution and benefit LIV consumers more generally:

- the creation of a central database of LIV consumer use data would be a valuable asset for testing solutions;
- government review of funding structures to incentivise benefits for social landlords on full ownership costs of heat pumps and optimising technology over lower upfront costs;
- the consideration of a social tariff or heating cost support, and ways that could be integrated with an optimiser service.



4.5 Repowering Homes

The Repowering Homes solution has developed and trialled a survey and retrofit co-design service tailored for blocks of flats with a high proportion of low-income households. The service was designed to facilitate the adoption of smart, flexible, low carbon technologies, including communal solar photovoltaic systems, heat pumps, and enhanced ventilation and insulation solutions, which individual households may be unable to access. Such upgrades can be costly and disruptive, and renters in blocks of flats often face complications due to contractual and practical issues. Repowering Homes tackled these issues with their service, which was of particular benefit to LIV energy consumers.

4.5.1 Aims

The primary objective of the Repowering Homes ISS trial was to expand access to smart energy retrofit solutions for LIV households in blocks of flats, and to ensure that the service meets the needs of those residents at an affordable cost. Smart energy retrofit solutions are generation, storage and management technologies that can be combined to reduce strain on the network at peak times and optimised for cost and energy efficiency. More generally, the innovator hopes to provide greater access to these technologies through their people-first service, meeting the needs of residents at an affordable cost, informing early stage retrofit planning and decision making for blocks of flats, and de-risking the process.

The broad service aims therefore target: consumer barriers, in terms of accessing and implementing technologies; commercial needs, both for the innovator's business model and in terms of paying for smart retrofit solutions; and market needs, given the substantial proportion of LIV consumers that are renting or residing in blocks of flats (as established during Phase 1). The research undertaken during the ISS trial aimed to test the viability of the service in meetings these aims.

4.5.2 Approach

The Repowering Homes solution involved a co-designed retrofit appraisal and planning service, which targeted blocks of flats with a high proportion of LIV households. By bringing the needs of LIV consumers into the smart retrofit design process, the service fostered engagement and support for the uptake of low carbon smart energy solutions. In contrast to the other ISS innovators, this solution is geared towards a people-first, technology-agnostic journey, as opposed to a specific technological or financial solution.

In brief, a 'minimum viable service' offering comprised:

- appraisal of the building and of a sample of flats;
- consultation with residents via an online (and telephone) survey and two community engagement events;
- analysis of resident smart meter data;
- resident and landlord 'smart plans', with information regarding low carbon energy performance improvements to individual homes and the block.

Overall, 26 flats took part in the service out of a total of 174 flats at the block of flats. Of those that took part, 48% lived alone, 22% were over 65, and 37% had a low income. All of the participants lived in a flat, one of the 'at-risk' groups identified during Phase 1.

However, there were gaps in representation from renters (15% of participating flats) and people with disabilities (11% of participating flats).

Research to appraise the service took the form of semi-structured interviews with board members (n = 2); interviews with landlords as part of the commercial modelling work (n = 7); and resident-facing research, including during the community event (n = 6), during telephone support conversations (n = 1), and at the completion of the trial (n = 7). The research was predominantly qualitative in nature, analysed using a thematic approach, with quantitative data (e.g. demographics, LIV consumer group) serving to contextualise some of the findings. Complementary desk research has also been undertaken, including reviews of relevant policy and regulation as part of the commercial modelling work.

4.5.3 Key findings and conclusions

Consumer

Generally, participants found the Repowering Homes service to be valuable. Engagement with the Board at the block of flats brought to light concerns about moving too quickly with service delivery, and of the risk of overwhelming residents in finding the right balance for resident engagement. While specific to this trial, these findings may be reflective of some of the challenges engaging blocks of flats more generally.

A key finding from the resident engagement aspects of the Repowering Homes service also highlighted the challenges of engaging participants within blocks of flats. For instance, there were difficulties reaching individuals who did not take part in the service for comment, including due to reluctance from the board to permit direct contact with this group. Resident engagement within the constraints of this trial proved to be effective but challenging. More generally, engaging with a higher proportion of residents within a block of flats may prove to be a challenge for service innovators.

Renters and those with disabilities were also under-represented in the sample. The lack of renter representation has implications for future service delivery where blocks of flats are targeted. It is unclear whether the lack of engagement from individuals with disabilities was reflective of the composition of the residents in the block, and is therefore more difficult to draw conclusions from. Nonetheless, this finding highlights the importance of targeted engagement strategies when delivering a service of this kind.

The Repowering Homes service was co-designed with Experts by Experience to ensure the LIV consumer perspective was captured throughout. A pertinent finding was that landlord perspectives should also be considered from an early stage, to help identify and mitigate potential issues in communicating with consumers.

Similarly, the way in which communications are provided to residents in particular has been highlighted throughout this project. For example, tailored, trusted communications (e.g. co-branding with partner organisation), which include accurate information have been identified as potentially important features for innovator communications.

Finally, it was difficult to gather participants' smart meter data during the trial. This is perhaps reflective of barriers to installation within blocks of flats, such as physical access limitations, and resident awareness and engagement, along with data sharing concerns more widely. Residents'

engagement in a future smart energy system will be largely precluded without greater smart meter installation and, to a lesser extent, data sharing. Interventions targeted at smart meter rollout within blocks of flats may be an important element of LIV engagement.

Business and commercial

This trial has demonstrated financial viability of innovator services in this space. However, similar services may fall between certain funding mechanisms, which are typically allocated to installers, housing associations or retrofit organisations, and which are often focused on the latter stages of the retrofit journey.

Funding issues are likely to affect other innovators, especially those acting as intermediaries or focusing on community interventions with multiple stakeholders, with potential implications for policy design.

Policy and regulation

The Repowering service trial has confirmed some of the difficulties in working with blocks of flats, with implications for policy and regulation. Often, these have related to communication and engagement across the range of stakeholders: renters, owner-occupiers, landlords, board members and so on. Subsequent implementation of smart technologies would also involve third parties, such as retrofit assessors, installers, and energy suppliers and operators. These issues may be further complicated by any ongoing monitoring and maintenance required. Policy which directly targets the collaborative engagement of respective parties, and which serves to expedite progression through decision processes and stage gates, may play an important role in facilitating the participation of flats – and by extension LIV consumers – in a future energy system.

4.5.4 Innovator next steps and recommendations

Overall, the trial undertaken within the participating block of flats has demonstrated the viability of the minimum viable service, showing good prospects for engaging LIV consumers in smart, flexible energy technologies. Challenges remain for Repowering London and other service providers aimed at tackling smart retrofit within blocks of flats.

As indicated earlier, there were difficulties engaging the full range of tenure types across blocks of flats. This was an anticipated issue and could be considered as validating the need for dedicated services that target mixed-tenure blocks. Repowering London will need to build upon this insight to better target all tenure types, such as through direct resident communication and repeated 'waves' of engagement activity.

In terms of the implementation of smart retrofit measures, questions remain as to how to inform and engage residents about next steps, including liaising with installers and managing community technologies. Future research and trials could therefore aim to target this element of the journey for innovative service providers. A further facet of future research could feature different types of landlords, particularly smaller-scale private landlords, along with managing agents, whose input was limited in the present trial.

Next steps for the innovator will include further developing the financial model and commercial approach to ensure viability of the service, which may depend on external funding. A potential target of the service could include social housing, though more research in this context would be needed. Repowering London could also consider where and how collaboration

may be necessary or financially viable and ensure that minimum service delivery and requirements are well defined. For example, understanding the data requirements for the energy modelling work would help to ensure the overall effectiveness of the service where data is missing. Further, Repowering London should also look at where upskilling or hiring of permanent staff may be financially beneficial in the long run. This may be pertinent in the case of carrying out consumer and commercial modelling research, wherein Repowering London have engaged closely with delivery partners as part of this project, and where future value is likely to be obtained from both understanding consumer needs and commercialisation approaches in aiming to improve the Repowering Homes model.

4.6 Phase 2 summary

The research undertaken during Phase 2 has helped lay the groundwork for the innovators involved to progress their solutions, informing future research, business and commercial model refinement, and potential future solution development. The involvement of external project delivery partners in this phase enabled an independent perspective, often asking difficult questions of innovators' solutions and delivery models. Moreover, involvement of experts by experience during design and delivery helped to tailor each solution to focus on the specific needs of LIV consumers.

Each of the solutions described above has offered a unique approach and perspective on the engagement of LIV consumers in smart energy products and services. The diversity of projects in this phase has offered a wide-ranging understanding of the barriers faced by both LIV consumers and innovators in the current energy system.

Service-based vs product-based solutions

A distinction can be made between the programme innovations geared towards delivering a service to users (i.e. Changeworks, Repowering) and those developing specific products and technologies (i.e. equiwatt, Homely).

It is apparent from the solutions trialled in Phase 2 that the barriers to deployment of service-based innovations may be more complex than product-based innovations, typically involving additional stakeholders and falling through the cracks of existing funding mechanisms. Yet, service-based innovations could offer LIV consumers the greatest potential benefit to engaging in a smart, flexible energy system. Unlike product-based innovations, services may help to engage consumers who currently have limited access to smart, flexible energy.

Without greater support and certainty, service-based propositions may struggle to market and deliver the full extent of benefits to LIV consumers, and may have difficulties attracting investment or funding. By extension, innovators seeking to advance their offering by developing wrap-around services for their products may experience barriers to doing so.

Clearly, product-based solutions are required to deliver a smart and flexible energy system, and ongoing support will also be necessary for innovators in this space. From this research, however, further emphasis is required for solutions that meet LIV consumer needs from a services perspective. It may be that achieving a future energy system requires the gap between services- and- products-based propositions to narrow, with innovators supported to develop and collaborate on both the technologies and the end-to-end services that enable LIV consumers greater access to, use of, and benefit from those technologies.

Who pays?

Another key consideration emerging from the innovator projects relates to the business and commercial models, and how these interface with LIV consumers. An issue across innovators was funding mechanisms, despite an array of approaches being trialled. This may be reflective of the overall challenge associated with sourcing revenue via LIV consumers, who may be less willing or able to pay for products and services than other consumers. Further, small incentives may not be sufficient to engage LIV consumers with smart energy solutions. This creates difficulties for innovators seeking to develop solutions which target LIV consumers, whereby funding routes may lack certainty and have greater complexity.

For the solutions trialled in Phase 2, innovators capable of accessing economies of scale, such as through technology (e.g. Homely), or operating at least in part via energy suppliers or operators (e.g. equiwatt), may be more resilient to the challenges of accessing funding for the LIV consumer base. This has implications for the way markets are geared towards certain innovations. Enabling innovators to mature their business and commercial models in order to improve targeting of particular funding sources was a key benefit of the ISS programme. However, ongoing commercial viability of these solutions, and indeed further innovation, is likely to rely on additional support.

Phase 2 conclusions

Overall, delivery of the ISS programme has supported innovators in the furthering of their consumer, commercial and regulatory awareness, helping to advance their propositions and inform future work. Some key barriers persist for the innovators involved, and for other innovators in this space, if LIV consumers are to be effectively engaged in a smart future energy system. Future programmes informed by ISS could aim to foster further forms of innovation, such as those relating to electric vehicles, to understand the barriers to market and consumer engagement for a wider array of solutions. Future programmes should also build upon the present research with LIV consumers, guided by the characteristics of consumers at most risk of being locked out of a future energy system, as outlined in Phase 1.

5. Programme insights

In this section, we present and discuss a synthesis of the overarching programme-level insights for ISS, drawing heavily on the work carried out during Phase 2. The aim of this section is to go beyond the key findings from each of the four projects, described in Section 4, instead demonstrating the higher-level conclusions that can be drawn from across all of the projects. The potential implications of these insights are discussed in Section 6.

5.1 Approach to gathering insights

Insights described in this section have been generated across the research streams undertaken for each project, collated, tested and refined. This process has involved project researchers alongside expert stakeholder perspectives from across the Catapult, the innovators, delivery partners and DESNZ. Activities included:

- iterative discussions with each project's technical lead, individually, to reflect on learnings and insights within each project;
- collaboration sessions with the technical leads from all four projects to reflect on emerging insights across the programme;
- workshops with delivery partners;
- iterative discussions and a workshop with experts (representing policy, digital, systems and innovation perspectives).

Emerging themes and insights were updated after each activity to allow evolution of the insights to be tracked from project to programme level and to support the translation of insights into the principles and recommendations outlined in Section 6.

This has ensured a rounded approach to thematic identification; however, it should be noted that these insights reflect the Catapult's interpretation with respect to the findings of the ISS programme, drawing on the expertise of those involved.

5.2 Context for insights

The insights provided in this section necessarily stem from the projects undertaken in Phase 2. The nature of those projects therefore bound these insights, in terms of each project's focus, scope and research participation.

The four projects were deliberately divergent, varying in terms of:

- nature of the solution (e.g. service, technology);
- the problem or barrier the solution sought to address;
- LIV consumer group targeted;
- target customer;
- business model and level of commercial readiness;
- research methods used to test the solution.

This variation naturally means this programme does not provide an exhaustive evidence base. However, the diversity of consumers and contexts represented across the four projects helped identify programme-level learnings which could be challenged and refined from different perspectives, with evidence from different consumer groups and contexts, to generate a set of fundamental insights. These insights in turn supported the development of a wide-reaching set of recommendations and implications.

The research carried out across the four projects involved recruiting a range of LIV participants and stakeholders, who in turn played a role in shaping the research outcomes. The compositions of the samples taking part in in-depth research are outlined below.

LIV consumer sample

Across all projects carried out in Phase 2, the total number of LIV consumers taking part in in-depth research was 96. This sample was composed of consumers from the following groups, informed by Phase 1 and prior research:

- Low household income (<£30,000)
- Renters (social and private)
- Individuals with disabilities or long-term health conditions
- Those living in flats and maisonettes
- Pre-payment meter consumers
- Those living alone
- Those aged over 65.

It should be noted that sampling from each of these groups was not purposive, and there were representation gaps from certain consumers, including those with disabilities and renters.

Stakeholder sample

Across the commercial and business modelling work, in addition to case studies and desk research, interviews with ecosystem stakeholders were conducted, as follows:

- Social landlords (n = 14)
- Financiers (n = 4)
- Energy suppliers and Distribution Network Operators (n = 4)
- Other ISS service providers (n = 5)
- Internal Carbon Trust expert stakeholders (n = 8).

Additionally, stakeholder input from across the innovators was sought.

5.3 Three insights lenses for innovative solutions

The programme insights presented in this section have been developed through three distinct lenses: consumer perspectives, especially LIV; policy and regulation; and business and commercial (Figure 4).

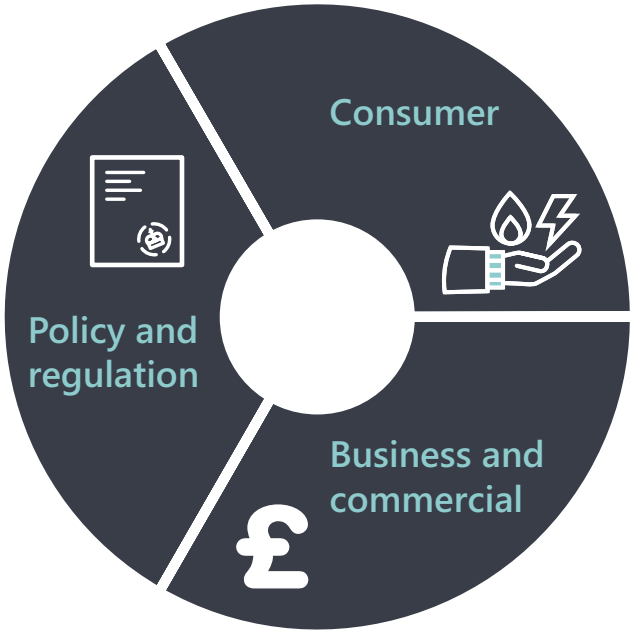


Figure 4. Three lenses adopted for programme-level insights

5.3.1 LIV consumer perspectives

From the work of delivery partner TPX Impact, and of experts within the Catapult, several consumer insights are highlighted in this section from across the ISS programme. These centre around some of the most common barriers LIV consumers face in accessing smart energy solutions. Many of these barriers are faced by consumers as a whole and are therefore informative to wider consumer engagement.

Difficulty in finding out about energy flexibility

Consumers face several challenges to their engagement in learning about flexible energy services and its benefits.

First, the current consumer smart energy market is complex and not well developed. For many LIV consumers, expensive, long-term investments aren't practicable, meaning existing ownership models aren't a viable option. LIV consumers may be apprehensive about their ability or capacity to flex their energy usage and, with low trust in the energy sector, flexibility and associated new technologies may be viewed with a degree of suspicion. Consumers also gather information from multiple sources, with some emphasising certain sources over others. Special consideration to the needs and preferences of LIV consumers (e.g. digitally excluded) when accessing information to make informed decisions about smart solutions is therefore required.

Barriers to accessing smart products, services and tariffs

Tenants appeared to face particular barriers in accessing smart solutions. They may be unable to choose particular products due to relying on their landlord to make improvements, potentially having to navigate complex and unclear tenure agreements, or communicating via estates and managing agents. Smart meter access appeared to be an issue for several tenants within blocks of flats, with uptake currently low.

Tenants may also perceive challenges to accessing solutions, such as gaining agreement from neighbours within blocks of flats and may seek to safeguard the perceived limited control they currently have, including having a say in what and how upgrades are made.

Further, information about solutions can be overly technical and piecemeal, without giving due regard to a holistic approach or the bigger picture of smart and retrofit improvements. They may also feel that energy information is often too generic, preferring and trusting advice which is tailored to their circumstances. Consumers also have concerns about a perceived lack of evidence for novel, smart technologies, with trust potentially being eroded within the context of a confusing landscape of solutions and new partners.

Paying for smart products, services and tariffs is disproportionate for LIV consumers

When it comes to paying for smart energy improvements, LIV consumers face disproportional purchasing barriers. Follow-on costs are also a concern, such as higher bills or increased rent, particularly where solutions cannot guarantee cost savings for consumers. Familiar payment methods are also likely to be preferred, including via prepayment meters and rent. However, for tenants, a warm home is considered a right, with many feeling that they shouldn't have to shoulder the cost of smart retrofit installations, or the burden of entering a new contractual relationship with a third-party energy service provider, particularly where these will increase the value of the property for the landlord. Moreover, funding routes may be inaccessible or difficult to navigate for consumers.

Lacking the means to use energy in a flexible way

There is likely to be a limit on the extent to which LIV consumers are able to flex their energy usage. Some are unable to flex due to family routines or medical needs, whilst for those living in blocks of flats, off-peak usage may be considered as causing a disturbance to neighbours. Some tenants may already be flexing merely to comply with their tenancy agreement or building rules, such as using cheaper communal laundry services available at specified times or adhering to noise restrictions.

LIV consumers may already be doing as much as possible to keep energy costs down, making use of alternative means of heating themselves (e.g. electric blankets, layering up), and using central heating only minimally to meet their basic needs. Having a high degree of control over their energy use enables LIV consumers to keep on top of costs. As such, automation which removes this control can seem off-putting or unnecessary, unless it can provide guaranteed cost savings. Furthermore, smart tech which is accessible and provides clear benefits is more likely to be used, with many LIV consumers not making use of existing smart products. Even with accessible products, many consumers will still require in-person support rather than digital-only solutions, such as those with low digital literacy.

Flex rewards and benefits are disproportionately low for lower energy consumers

For LIV consumers, for whom cost saving is a priority, flexing usage may be difficult to achieve and is unlikely to yield material rewards where energy usage is already low. As demonstrated within the equiwatt trial, whilst the environmental benefits of saving energy may be important to consumers, they are unlikely to take precedence over cost considerations. Flexibility must, therefore, focus on helping consumers to save money, or on delivering a better service.

However, where incentives for flexing usage are relatively low, there is a risk that some LIV consumers might not perceive these rewards to be sufficiently motivating to encourage participation in flexibility. The delay in receiving rewards may also be a barrier to taking part. LIV consumers are also likely to be wary where benefits cannot be guaranteed, which is a particular issue where cost savings for solutions have been modelled on average households rather than those with restrictive usage.

5.3.2 Business and commercial viability

From the work of delivery partner Carbon Trust, and of experts within the Catapult, several business and commercial modelling insights are highlighted in this section.

Better engagement with social landlords and other ecosystem partners

Social landlords and other ecosystem stakeholders (e.g. charities, consumer advocacy groups) need to be consulted and considered when targeting adoption of smart solutions by LIV consumers.

Social landlords represent a key decision maker when it comes to retrofit and smart installations, and play an active role in consumer engagement, aiming to understand tenant needs and barriers. Therefore, working with social landlords in a structured way will be critical to ensuring the effective rollout of smart solutions, especially important to improving the participation of LIV consumers given their high representation within social housing. This could involve direct collaboration with social landlords' engagement teams, or broader programmes of education and engagement.

Targeting social housing also brings unique challenges, including budgetary constraints, strict adherence to regulation, and concerns surrounding the relevance and effectiveness of smart technologies for this consumer group. Nevertheless, there are opportunities here for innovator solutions that address budgetary constraints (e.g. through access to finance), adherence to regulation (e.g. improving EPC ratings), and improving tenant comfort (e.g. solutions that provide guaranteed heat). Future research could aim to focus on the challenges and opportunities innovators might face specifically when targeting social landlords, aiming to build a body of evidence to demonstrate the viability of solutions within this sector and further understand the impact on consumers.

Alongside a focus on social landlords, the full supply chain needs to be considered for innovative solution development. This could include customers (of the solution), delivery partners, funding providers and channels to market. The engagement of LIV consumers with smart solutions depends upon effective collaboration and consultation of diverse market players. Clearly, solutions will vary in their level of engagement with different stakeholders, based upon their focus on technology or service-based propositions, for instance.

The importance of evidencing the value of inclusive smart solutions

There may be an 'understanding gap' in the potential value of smart and flexible energy solutions. Such solutions may be seen as high-risk for customers and consumers, with real-life evidence and structured engagement needed to play a fundamental role in bridging this gap.

For LIV consumers, there appears to be a preference for predictable and cost-effective solutions over environmental and other benefits, as illustrated in the equiwatt trial. Social landlords are also sensitive to this issue and are reluctant for their tenants to be 'guinea pigs of innovation' that may seem untested, furthering the importance of communication and education with engagement teams.

There is also a tension between ease of use for technologies and mistrust of automation, which may be more apparent for LIV consumers. While automated solutions may be easier to use and offer more guaranteed benefits (e.g. savings), potentially mitigating issues relating to misuse and disuse, they also reduce consumer choice and may be difficult to understand. Financial incentives for partaking in flexibility may be unlikely to offer LIV consumers sufficient benefit in cases where energy usage is already low. Innovators will need to consider these issues on merit for any

given solution, which may require additional user experience and communications support.

A promising means of tackling communication and value concerns is to demonstrate the value of solutions to consumers and prospective customers with real-life examples. The ISS programme has enabled this opportunity for the innovators involved. Innovative solutions by their very nature are difficult for stakeholders to engage with, due to their novelty, upfront costs, low margins and the unpredictability of consumer behaviour. This is especially likely to be true of the smart solutions participating in the ISS programme, with novel technologies, complex property archetypes and uncertainty around the LIV consumer market. Accordingly, high quality evidence, such as in the form of small-scale pilots and case studies, will play a pivotal role in demonstrating the feasibility and value of solutions. This evidence is likely to take multiple forms, including smart meter data, verified energy predictions, exemplar projects and testimonials. Ultimately, this evidence, whilst challenging for innovators to collect, would help garner support and confidence from a spectrum of stakeholders.

Improving understanding of available finance options for innovators

Financing routes are a key barrier to innovative and inclusive smart solutions, with innovators often hamstrung by a reliance on funding via third parties.

Whilst social landlords are a key enabler and primary customer for smart energy solutions that benefit LIV consumers, neither they nor their tenants can bear the full costs of deployment. A broad-brush approach to funding may therefore be adopted by innovators. Moreover, social landlords' implementation of retrofit and smart technologies is currently based on adherence to regulation, with little opportunity to recoup costs or access finance.

In the short and medium term, grant funding (e.g. ECO4; Social Housing Decarbonisation Fund, [SHDF]) provides a lifeline for some innovators and can help to de-risk pathways to scalability by investors, but may not be a reliable long-term solution due to the competitive or inconsistent nature of many grant funding programmes. New revenue streams from smart energy solutions could potentially help to supplement grants and other forms of funding, and improve investability.

A further consideration relates to asset ownership of smart energy technologies. Current models typically focus on consumer ownership of technologies, but given that this may be prohibitive for many LIV consumers, alternative ownership models could be explored, including those which focus on de-risking investment and ownership by landlords. Further innovator research will be needed to establish the feasibility of alternative asset ownership models.

5.3.3 Policy and regulation landscape

Insights from the current policy and regulatory landscape pertinent to innovators and consumers are highlighted in this section.

Maturing consumer engagement with smart solutions

From the research carried out in ISS, the existing regulatory framework does not appear to be adequate for supporting tenants (and landlords) to engage with smart and flexible products and services. Clarity and confidence are needed on payment and funding mechanisms to enable tenants – identified as likely to be 'locked out' of future energy – along this journey. Current consumer awareness and understanding of the future smart energy system may prohibit effective rollout. Nationwide and targeted communication campaigns may be needed.

Current consumer incentives for participating in smart energy, and in particular flex, may offer insufficient benefit to consumers, particularly for those who already restrict usage. Simplified messaging, with clear and direct benefits to consumers will be needed, along with alternative incentive models which do not emphasise further energy reductions and which enable cost savings. Consumer protections may be lacking within the existing smart energy market, such as guaranteed cost savings or levels of service. However, a more nuanced understanding of LIV segments and their particular barriers may help to further refine the policy and regulatory landscape.

Fostering engagement with social landlords

Social landlords are perhaps a special case in that they represent the needs of tenants who are likely to be LIV consumers, and are therefore a key player in the rollout of smart solutions. Presently, there are several barriers to their involvement, outlined above, which have a knock-on effect for tenants' engagement. Funding, market, regulation and insurance mechanisms are currently inadequate for social landlords to effectively rollout smart, flexible energy. In turn, innovators which are reliant on funding via third parties may struggle to engage social landlords.

Recognising and supporting the needs of small and medium enterprise innovators

New and emerging smart energy innovators may struggle within the current policy and regulatory landscape. There is a lack of guidance, signposting, research and user design support, business and commercial advice, and tenant engagement strategies. Ensuring joined up working with the right support and collaboration will be crucial to fostering innovation. Existing finance mechanisms are also a barrier to some innovators. Additional funding routes, such as bank retrofit loans, may be required to enable a breadth of innovator solutions to propagate within the market, such as those targeted in the Green Home Finance Accelerator[14] projects.

Accessibility requirements represent a key element of design for including LIV consumers (and consumers more generally) in future smart technologies, yet many small businesses lack the expertise or resources to develop solutions which meet best practice. Consumer protections more generally are important; however, their impact should be considered in the context of small businesses.

Bringing consumer advocacy groups along the smart solutions journey

The third sector may play a key role in supporting LIV consumers through the energy transition. They may also offer assurances and advice surrounding accessing and benefitting from new technologies and services and may

[14] Carbon Trust (2024). Green Home Finance Accelerator (GHFA). https://programmes.carbontrust.com/ghfa/.

play a critical role in upholding consumer protections. However, a lack of resources and funding within this sector, together with wider societal and consumer needs, makes it challenging for these organisations to fully engage with smart future energy.

Tackling data sharing issues

Data access is an issue for innovators, consumers and the network. For example, limited smart meter data may impact on the ability of innovators to demonstrate the value of their solutions to consumers and prospective investors, or to tailor their services to individuals and communities. The current regulatory landscape makes it difficult to access and share consumer data between partners. A slow smart meter rollout more generally, particularly for tenants in blocks of flats, will ultimately prevent consumers from accessing the full benefits of smart solutions.

5.4 Insights synthesis

Together, the above insights lenses – consumer, business and commercial modelling, and policy and regulation – paint a picture of the status quo of the smart energy market and point to areas for improvement to facilitate LIV consumer engagement. Synthesised, high-level insights are provided in Table 2 based across the ISS programme. The implications of these insights are discussed in Section 6.

Insights can be summarised into three topics:

- Innovation that offers LIV consumers relevant and appealing benefits that help them meet their needs will encourage uptake of smart, flexible solutions.
- It should be easy for LIV consumers to access and use smart, flexible solutions.
- LIV consumers need to feel they trust what they're offered in an evolving market and be willing to share their data.

These insights align with and build upon previous research, such as in relation to the call for addressing obstacles for LIV consumers in accessing, purchasing and using smart products and services.

Topic	Insight	Detail
LIV consumers should be offered relevant and appealing benefits	**LIV consumers may not perceive smart or flexible solutions to offer relevant or valuable benefits**	• They may not be motivated by the benefits they perceive smart solutions to offer. They may be reluctant to trust automation to manage their energy use, preferring to maintain a feeling of control by managing this themselves. Other benefits (e.g. environmental) may not be sufficient to encourage flexibility. • They may not perceive that the benefits on offer are achievable for households like theirs.
	Small and uncertain rewards may not be enough to encourage LIV consumers to participate in flexibility	• Rewards for participating in flexibility can be small and uncertain. With estimates often based on household consumption, rewards may be smaller still for LIV households who ration their energy use to keep costs down. Small rewards may not be enough to encourage some LIV consumers to participate in flexibility. Uncertain rewards can make it difficult for LIV consumers to make informed decisions about the value of participating in flexibility, particularly if it may inconvenience them. • Services which provide guaranteed benefits for consumers may help them make informed decisions and offer a way to further engage them within a future smart energy system.
	Historical usage provides an inaccurate account of consumer requirements	• Many LIV consumers restrict their energy usage to control costs. In these instances, consumption data will reflect this rationing. • Smart solutions which rely on consumer usage data may need to factor in restricted usage.
Adoption of and engagement with smart solutions should be facilitated for LIV consumers	**Enabling access to smart solutions doesn't mean they'll be used in a smart way**	• Awareness of and engagement with smart, flexible solutions is low amongst LIV consumers. • Without access to relevant assets (e.g. batteries), LIV consumers may lose out in the long run if they are unable to flex or shift their usage to the same extent as other consumers. Smart solutions may need to be interwoven with retrofit, low carbon technologies and tangible benefits to be considered worthwhile by consumers. • Accessibility limitations for smart technologies will have an impact on how they are used. • Not all consumers will be motivated to use smart technologies in a smart way. Poor incentives, concerns over being worse off, or a lack of support could prevent LIV consumers using smart solutions as intended. • Automated smart solutions which cannot guarantee benefits may not be trusted by consumers, and diverge from existing models of consumer choice.They may not perceive that the benefits on offer are achievable for households like theirs.

Topic	Insight	Detail
Efforts need to be made to build and maintain LIV consumers' trust in an evolving market	**LIV consumers may lack trust in novel solutions and partners and be reluctant to share their data**	• LIV consumers, who often already lack trust in the energy sector, may not trust novel solutions and propositions and may need advice and reassurance about how these can work for households and situations like theirs. • They may prefer solutions delivered within familiar formats (for example managing costs within existing contracts rather than introducing new charges) or relationships (for example a familiar and reputable housing association rather than a novel commercial entity). • They may need tailored advice and reassurance about how sharing their data can benefit them, particularly where propositions are novel and involve unfamiliar organisations.

Table 2. Programme-level insights.

6. Implications and recommendations

This section outlines the implications of the programme's findings and introduces a set of recommendations that could address these. To help the reader navigate this section, these recommendations are introduced as follows:

- Firstly, we outline the ambition that any action should seek to support.
- Then, we propose three principles that any actions to achieve these ambitions should meet.
- We then introduce a set of recommendations that could meet those principles.

6.1 Ambition

In line with the objectives of the ISS programme, action is needed across the energy sector to enable and leverage smart solutions to deliver benefits for the energy system and consumers.

Smart solutions should enable valuable consumer-led flexibility, e.g. flexibility (delivered through assets in homes) that:

- benefits the energy system: delays the need for network upgrades; reduces capital and operational costs of generation and grid storage; helps manage high impact, low probability events[15].
- benefits consumers: offers consumers relevant and appealing benefits that encourage participation, such as more affordable bills, and is easy for anyone to participate in.

Innovation that enables and supports consumer-led flexibility should focus on helping all kinds of different consumers to meet their needs – encouraging uptake of smart solutions and engagement in a smart, flexible energy system – while enabling the flexibility that the system needs. Innovation should cater to the needs of LIV consumers just as it does to the needs of other consumers. LIV consumers should be supported to access and make use of smart solutions that can help them better meet their needs and benefit from direct participation in flexibility. To do this, innovation must consider and design for the needs and situations of LIV consumers. Without this, there may not be sufficient public buy-in to:

[15] Energy Systems Catapult (2024). Enabling Distributed Flexibility for Net Zero: How to unleash the full potential of behind-the-meter flexibility. https://es.catapult.org.uk/report/enabling-distributed-flexibility-for-net-zero/

- Realise energy system benefits: a substantial proportion of UK households are low income and/or vulnerable. The extent of flexibility the system needs may not be realised if innovation predominantly targets those who are willing to participate and able to afford the smart solutions that enable their participation. Households of all sizes and types should have the opportunity and incentive to directly participate in energy flexibility.
- Deliver relevant benefits that appeal to varied consumer groups: if low income and vulnerable households are not catered for, consumer benefits will be disproportionately available to and accessed by those who are willing and able to participate. Inclusive smart solutions which encourage and support low income and vulnerable households to directly participate in flexibility could help improve affordability and equity through new ways of buying and using energy that help people better meet their needs.
- Meet Net Zero targets: low-carbon technologies must be inclusive and suitable for all kinds of consumers if they are to be taken up in the number and at the pace needed to meet Net Zero targets while enabling flexibility to mitigate the impact on the network.

Without widespread and inclusive consumer participation from all types of consumers, including those living on low incomes and/or in vulnerable situations, flexible, low carbon assets may not be rolled out at the pace or in the number needed to meet Net Zero targets. Rolling out low carbon technology without smart functionality risks negative impacts on the network and could leave consumers unable to effectively and affordably meet their needs.

LIV consumers should be engaged now, not further down the line. Not only are a substantial number of GB households already struggling to meet their needs, but any household could find themselves in this position at any point, even if they have never been low income and/or vulnerable before. Ensuring solutions offer and enable something valuable for LIV consumers doesn't isolate others, but designing for those who aren't LIV risks isolating those who are.

The fundamental principle of this ambition is that smart solutions could simultaneously address the need for flexibility capacity and the need to alleviate fuel poverty. Without this holistic ambition, there is a risk that steps taken to enable flexibility exclude LIV households, sustaining – if not growing – the inequality that already exists and increasing the need for investment and initiatives to support those who are struggling.

6.2 Principles

We propose three core principles that should be met by any action designed to help achieve the above ambition, each reflecting one of the key insights topics generated across the four ISS projects (as summarised in Section 5.4).

Smart solutions should help LIV consumers meet their needs.

No household should be negatively impacted or inconvenienced on a day-to-day level by system needs for flexibility. This is particularly the case for LIV consumers who are already struggling to use energy to meet their needs, affordably.

Innovation should focus on designing solutions that offer LIV consumers relevant and appealing benefits. These should consider and cater for the variety of needs that different LIV consumers have and their differing circumstances. Solutions should be delivered in a way that makes it easy and affordable for them to meet their needs.

LIV consumers should be equipped to make informed decisions about the value of participating in flexibility and, when they choose to participate, should be supported to shift their consumption away from peak times (rather than just reducing it at peak times).

It should be easy for LIV consumers to access and use smart solutions.

LIV consumers should be able to easily navigate and evaluate what is on offer. They should be able to use smart, flexible solutions easily and confidently to get the promised benefits. They should also understand the implications of opting out and should be able to do so easily if they choose.

Where solutions are accessed through novel formats and relationships (e.g. outside of existing contracts, bills or relationships with existing parties) innovators should be responsible for communicating the benefits, requirements and implications of these propositions to consumers, in clear and relevant terms and using plain and simple language.

LIV consumers should feel able to trust what they are offered.

LIV consumers can lack trust in the energy sector, feeling it doesn't understand or cater to their specific needs and circumstances. They should have access to advice about how novel solutions might work for households like theirs and evidence that reassures them of the benefits on offer.

LIV consumers should have access to support to set up and use unfamiliar technologies in a way that builds trust in novel propositions and confidence in the benefits they can deliver. Support should be appropriate to LIV consumers' existing level of engagement with smart solutions, for example providing human support for those who may have lower levels of digital literacy. It should help them understand how smart solutions can support their specific household needs, for example giving clear cost information to enable informed decisions or reassuring them about the operation of medical devices.

LIV consumers should understand how they can benefit from sharing their data. They will also need to perceive sufficient value in the benefits on offer such that they are willing to share data on an ongoing basis. This data should be used to develop innovations and markets that help LIV consumers better meet their needs. Finally, policy and regulation should keep pace with emerging innovations to ensure consumer protection is appropriately updated and clearly communicated.

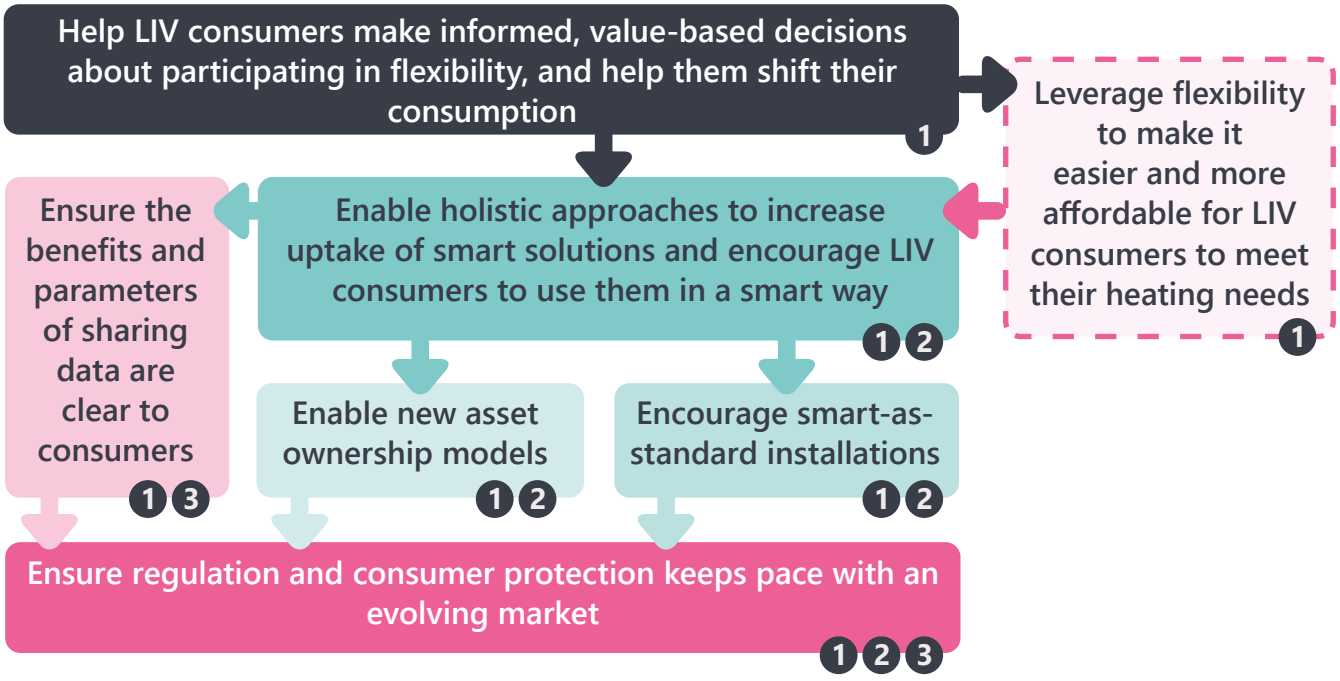
6.3 Overview of recommendations

Here we provide a visualisation of how our recommendations are structured, mapping out dependencies between them (Figure 5).

A shift towards giving LIV consumers what they need stimulates consumer demand for smart, flexible solutions. We have proposed that heat is prioritised here, as both a primary component of the electricity demand that the future energy system will need to deliver and an outcome that LIV consumers often ration in an effort to maintain affordability.

To ensure these solutions are taken up in a way that maximises their potential, a holistic approach is taken to: a) increase LIV uptake of smart, flexible solutions; and b) ensure they are used as intended.

Finally, given the pace and novelty of this evolving market, steps should be taken to ensure regulation and consumer protection are updated and appropriate for the delivery of the propositions on offer.



Mapping recommendations to principles

1. Smart solutions should help LIV consumers better meet their needs.
2. It should be easy for consumers to access and use smart solutions.
3. LIV consumers should feel able to trust what they are offered.

Figure 5. Programme recommendations and associated principles

6.4 Recommendations

This section details seven recommendations:

1. Help LIV consumers make informed, value-based decisions about participating in flexibility, and help them shift their consumption.
2. Leverage flexibility to make it easier and more affordable for LIV consumers to meet their heating needs.
3. Enable holistic approaches to increase uptake of smart solutions and encourage LIV consumers to use them in a smart, flexible way.
4. Enable new asset ownership models so LIV consumers can access assets – and the benefits they enable – without owning them.
5. Encourage smart-as-standard installations which are easy to use and meet household needs.
6. Ensure the benefits and parameters of sharing (and continuing to share) data are clear to consumers.
7. Ensure regulation and consumer protection keep pace with an evolving market.

Each of these recommendations is accompanied by:

Rationale: A brief summary of relevant learnings and insights from the programme (this will not exhaustively detail evidence covered in earlier sections of this report).

Proposed actions:
These are categorised into:

- policy, including regulatory recommendations;
- commercial, where that might refer (singly or collectively) to manufacturers, aggregators, energy suppliers and other existing or new market entrants developing and delivering new consumer propositions and business models;

Impact for LIV consumers, including direct and indirect impact.

Some actions will enable other outcomes that are not immediately relevant to the consumer, for example mitigating negative network impacts. These impacts have been considered in line with the ambition set out above. However, for conciseness and in keeping with this programme's focus on LIV consumers, this section will not outline those wider impacts.

1 Help LIV consumers make informed, value-based decisions about participating in flexibility, and help them shift their consumption.

Rationale

Current approaches to enabling flexibility typically encourage consumers to reduce consumption at peak times in return for a financial reward. Some LIV households may be unable to reduce their consumption at peak times: it may put them at risk (for example, if they have specific medical needs) or they may not be able to shift that consumption to other times (for example, some households living in flats may not be able to run certain appliances overnight). Some LIV households may be able to reduce their consumption at peak times, but might want to consider the value of reducing or shifting their consumption in pursuit of the reward – participation could be inconvenient or may introduce a risk of needs going unmet (for example, delaying the time of a hot meal or turning the heating on later than they might otherwise).

Rewards for participation are often uncertain in size but generally small. The size of the reward and the value it represents may also differ for LIV households and may influence participation in flexibility. Many LIV consumers ration their energy use, forgoing the energy required to meet their needs in an effort to maintain control over affordability. The lower level of consumption for these households can mean that the rewards on offer are very small (disproportionately so compared to those of higher energy users). These may not be sufficient to motivate people to engage in flexibility, particularly where the perceived inconvenience of shifting consumption is higher. Conversely, for some LIV households, even small financial rewards may be considered valuable.

LIV consumers should be given sufficient information about what is required of them and how they will benefit so that they can make informed decisions about the value of participating in flexibility. Information about what is required of them could include advice or support to help LIV consumers understand what they need to do, for example giving an indication of what sorts of actions could help reduce consumption and by how much. Information about how they will benefit could include, for example, a tailored estimate of cost savings if the suggested actions are completed.

As the need for and implementation of flexibility grows and participation becomes more frequent and dynamic, making informed decisions about every opportunity to participate will become increasingly inconvenient for consumers. Instead, they may benefit from opting in to ongoing, automated flexibility. To make an informed decision about the value of participating in this way, consumers should again be given sufficient information about what is required of them and how they will benefit. For the latter, that could be in the form of realistic estimates of financial rewards (e.g. savings on bills) or could be a reassurance that a certain outcome (such as a level of warmth) will be maintained while the asset delivering that outcome (e.g. a heat pump) is operated flexibly on the consumer's behalf.

Propositions that give LIV consumers easy and affordable access to energy at times of low demand could help offset the impact of reducing consumption at peak times. Enabling this through smart solutions could help reduce the inconvenience of shifting, particularly as peak and off-peak times become increasingly dynamic. LIV consumers may also welcome options that help them tailor automation to their specific circumstances, for example making sure a medical device operates continually, or making sure appliances don't run overnight if there are restrictions based on the property type.

1 Help LIV consumers make informed, value-based decisions about participating in flexibility, and help them shift their consumption.

Recommendations

Policy

Innovators offering smart solutions should be encouraged or required to make it clear how the benefits they offer are estimated. This might include establishing a suitable baseline reflecting realistic consumption of households who ration their energy use, and requiring that innovators use this baseline to estimate realistic savings (or other benefits) for such households. Information about how benefits are estimated should be accessible within existing consumer journeys (e.g. through price comparison websites) so LIV consumers can make informed decisions.

Appropriate safeguards should be put in place to ensure that LIV consumers reducing their consumption at peak times – whether through their own action or automated action – are not put at increased risk. For example, guidance could ensure that essential devices (e.g. medical equipment) are excluded from any flexibility, including where that flexibility may be delivered through another device such as a smart plug.

As the need for flexibility becomes increasingly frequent and irregular, the energy market could be developed to support propositions that automate flexibility on consumers' behalf. In the shorter term, consumers could, for example, pay for a certain level of consumption (i.e. number of kWh) and receive a rebate based on the flexibility they enable, whether through behaviour change or automation. In the longer term, service models could offer LIV consumers a choice of propositions that offer outcomes they value (such as heat) rather than kWh, for a fixed price. Innovators taking responsibility for delivering those outcomes could use automation to enable flexibility and leverage different revenue streams. While such propositions could benefit all consumers, they could particularly support LIV consumers who may value paying a fixed price or knowing that their bill will not exceed a certain amount. These propositions could also incorporate access to smart technology that enables automated flexibility, for example smart plugs or heat pumps, which LIV consumers may be less familiar with and may struggle to afford.

1 Help LIV consumers make informed, value-based decisions about participating in flexibility, and help them shift their consumption.

Commercial

Innovators who enable LIV consumers to participate in flexibility could build consumer confidence and trust in smart solutions over time, gradually increasing the extent to which they automate flexibility. For example, an innovator enabling participation in schemes like DFS could start by supporting LIV consumers to make occasional changes to their consumption and gradually increase the extent to which this is automated on the consumer's behalf, perhaps shifting from 'opt in' to 'opt out' arrangements. They could leverage increasing volumes of data to provide more specific and relevant benefits.

Innovators could increase the variety of novel offers that enable LIV consumers to access electricity in meaningfully cheaper periods. Access to cheaper electricity could facilitate shifting of certain behaviours away from peak times, allowing consumers to access financial benefits (e.g. rewards or savings on bills) without entirely removing a certain action or behaviour (such as preparing a hot meal or washing clothes). Increasing the variety of these offers could provide suitable options for LIV consumers facing different barriers. For example, cheaper periods during the day could be used by those who cannot use certain appliances overnight; cheaper periods on weekends could benefit those who have rigid weekday routines than make it difficult to participate in flexibility.

Innovators could use consumer data to offer LIV consumers advice that helps them participate in flexibility in a way that meets their needs. This could be general advice, for example illustrating how heating the home away from peak periods could help LIV households save money. Data could also enable more specific advice, for example how much money a given household could save if they routinely shifted a certain behaviour away from peak times.

Innovators should develop suitable support for LIV consumers (and other customers who may not be the users, e.g. social housing providers) to help them understand and navigate novel propositions and ensure they can easily and confidently use them to meet their needs. Support should reflect LIV consumers' current level of understanding and experience with smart technologies and energy products and services.

1 Help LIV consumers make informed, value-based decisions about participating in flexibility, and help them shift their consumption.

Impact for low income and vulnerable consumers

Direct

Access to lower-cost energy at times that are convenient and practical for different LIV consumers to use more energy could help them better meet their needs more affordably and/or encourage households to use energy that they might otherwise go without, for example having the heating on for longer or cooking a hot meal when they may have otherwise prepared a cold one. In turn, this could help them experience the benefits of meeting needs that they may have been unable to meet before, such as comfort and improved health. This experience could help them realise the value of these benefits and make informed decisions about taking up and using smart and flexible solutions.

LIV consumers taking up new propositions understand how the benefits of that proposition have been estimated, the extent to which they may be able to realise those potential benefits and can make informed decisions about whether those benefits are suitable and achievable for them.

Indirect

Innovators could use the data and insights enabled through this increased shifting and consumption to help deliver novel propositions which help LIV consumers better meet specific needs.

2 Leverage flexibility to make it easier and more affordable for LIV consumers to meet their heating needs.

Rationale

Heating is a key factor which LIV consumers consider when trying to manage their energy bills. Some ration their heating, going without to keep costs down. Others might face unaffordable bills as a result of trying to get the heat they need (e.g. to manage health conditions). They may get into debt and/or sacrifice other necessities to manage this.

In this way, LIV consumers often develop coping strategies that help them feel in control of their energy costs. They can be reluctant to change how they use and pay for heat if it disrupts these strategies and exposes them to risks that they do not feel in control of.

Consumption data that reflects LIV consumers' current energy use will reflect any rationing behaviours. This data is therefore not an appropriate baseline for designing and delivering solutions that give people the level of heat they need.

Recommendations

Policy

An energy system which allows for a 'second supplier' could enable fairer access to heat for LIV consumers and support their uptake of low carbon heating systems, without complicating other energy use within their home. For example, LIV consumers could run a heat pump around a dynamic tariff without having to consider if and how to shift other household consumption around this tariff too. The concept of a secondary supplier has been trialled by the Catapult[16]. Findings indicate that consumers may be willing to accept the secondary supplier model (and corresponding behaviour changes) if it saves them money, with recommendations made about expanding trials to more diverse consumer groups and identifying risks and unintended consequences. Propositions within the secondary supplier model could provide additional flexibility (depending on the appeal of consumer incentives), although policy and regulatory change would be needed.

Innovators could be encouraged to use modelled consumption data to design and cost smart solutions. Regulation could even require this and establish standards for innovators to follow. For example, the Low Income Low Energy Efficiency (LILEE) fuel poverty indicator considers the energy costs required to heat a dwelling to a satisfactory standard[17], a baseline which could be used instead of current consumption data to design smart solutions. To help ensure

[16] Energy Systems Catapult (2025). Living Lab Policy Trial: exploring the secondary supplier model. https://esc-production-2021.s3.eu-west-2.amazonaws.com/wp-content/uploads/2025/05/21121226/Living-Lab-Policy-Trial-exploring-the-secondary-supplier-model_-compressed.pdf

[17] DESNZ (2025). Fuel Poverty Methodology Handbook (Low Income Low Energy Efficiency): Statistical Methodology. https://assets.publishing.service.gov.uk/media/67e3d47bdcd2d93561195be6/Methodology_Handbook_2025.pdf

[18] Behavioural Insights Team (2023). How to build a Net Zero society: Using behavioural insights to decarbonise home energy, transport, food, and material consumption. https://www.bi.team/wp-content/uploads/2023/01/How-to-build-a-Net-Zero-society_Jan-2023-1.pdf

2 Leverage flexibility to make it easier and more affordable for LIV consumers to meet their heating needs.

LIV consumers are better able to meet their needs, an equivalent baseline could be used to mandate a minimum level of service that suppliers must deliver.

Suppliers could be assessed on the basis of ensuring fair access to heat. For example, there could be a price cap for a minimum level of service (rather than just kWh) or requirements for suppliers to support LIV consumers to achieve a minimum level of service.

Commercial

Innovators could harness data to understand LIV consumers' heat needs and leverage smart solutions and available revenue streams to deliver heat in a way that is affordable for those households.

Impact for low income and vulnerable consumers

Direct

LIV consumers would have access to the level of heat they need. They would be able to access that affordably and conveniently, as suppliers take responsibility for working out how to deliver the outcomes required within available budget.

Secondary suppliers could enable LIV consumers' heating to be operated around a dynamic tariff without further complicating their other household energy use.

Indirect

Delivery of valued outcomes could help increase the pace of electrification of heat, as consumers choose propositions based on the outcomes they offer and are confident in the technology and suppliers enabling those. The increased demand on the network is mitigated by the flexibility these solutions enable. This stands in stark contrast to a scenario where electrification of heat is achieved without being embedded in smart solutions and in which the resulting impact on the network has to be managed through consumer behaviour.

3 Enable holistic approaches to increase uptake of smart solutions and encourage LIV consumers to use them in a smart and flexible way.

Rationale

The full potential of system benefits can only be unlocked if low carbon technologies are installed as part of smart solutions that enable them to be used flexibly. However, installing smart technologies doesn't mean they will be used as intended. LIV consumers may 'opt out' of smart solutions if they are not confident that those solutions will meet their needs and/or are unable to access suitable support. They may not take those solutions up in the first place or may disable smart functionality whilst using them.

Funding that helps LIV consumers access smart, flexible solutions predominantly addresses the barrier of upfront cost. Whilst this might enable uptake of smart solutions, those solutions may not be used as intended and so may not enable the expected system and consumer benefits or return on investment for stakeholders.

Recommendations

Policy

A system map could be developed to help innovators, particularly those new to the energy sector, understand how smart, flexible solutions should be integrated within the energy system. This map could highlight examples of best practice, where available.

Such a map could also reflect the impact of potential policy or regulatory changes, giving innovators visibility of how the system might evolve and building confidence that the policy landscape around Net Zero and flexibility would continue to support the innovation and roll out of smart solutions beyond Clean Power 2030.

Commercial

Innovators should develop propositions that leverage smart technology to maximise LIV consumer participation in flexibility whilst ensuring consumers get the outcomes they need, minimising the perceived risk of taking up these new propositions.

Propositions could be supported by novel business models that help manage risks across different revenue streams. Innovators should communicate these propositions clearly to help consumers understand and identify the value they offer compared to other (including existing) options. They should support LIV consumers in understanding how to use these solutions to get what they need, including making sure support is easily accessed by all consumers (including those who may not be able to access online support).

Manufacturers should design products that are easy for LIV consumers to use, considering the products and interfaces themselves as well as how they might be used alongside evolving tariffs and services. For example, a smart thermostat's interface should not only be designed so that LIV consumers can easily see and understand relevant information and physically interact with that interface to execute any required actions, but so that it also helps them understand how changing a setting might impact other aspects of their service (e.g. cost).

3 Enable holistic approaches to increase uptake of smart solutions and encourage LIV consumers to use them in a smart and flexible way.

Impact for low income and vulnerable consumers

Direct

Consumers have a choice of propositions that help them meet their needs and can easily evaluate these to identify suitable options. They can easily and confidently use these solutions to meet their needs.

Indirect

Data enabled by the increasing uptake and use of smart, flexible solutions can be used to drive further innovation and offer increasingly relevant and differentiated benefits.

Innovators are encouraged and supported to enter the market. They are recognised as, and encouraged to, drive competition in the market.

4 Enable new asset ownership models so LIV consumers can access assets – and the benefits they enable – without owning them.

Rationale

Technologies such as electric vehicles, heat pumps and domestic batteries enable valuable flexibility, but are expensive. Upfront costs are a key barrier to adoption for many consumers and even more so for LIV consumers who are less able to afford the capital investment.

LIV consumers may perceive greater value in, and therefore may be more open to taking up, smart solutions in which they co-own assets with other stakeholders (e.g. social housing providers).

Options that support shared ownership of assets, for example with a social housing provider or other third party, could facilitate uptake of these technologies.

For some property types (particularly flats) and some households (particularly tenants) shared assets may be a more practical option than individual assets which can't or won't be installed in individual properties, for example due to physical size or access constraints or due to permissions being needed from landlords or leaseholders.

Recommendations

Policy

Allowing commercial solutions to leverage existing LIV support mechanisms, such as the ECO scheme, could help embed affordable access to low carbon technologies within broader business models and propositions that are specifically designed for LIV consumers.

Commercial

Business models in which multiple stakeholders are invested in ensuring an asset is appropriately maintained could spread operational and servicing costs across stakeholders and the life of the asset.

Manufacturers and innovators should consider how shared assets can be designed and optimised to meet the needs of individual households as well as the collective. For example, a shared battery solution serving multiple households within a block of flats should be sized appropriately, considering the diverse needs and consumption of the households it might serve, and costed to reflect the value to consumers and stakeholders.

Impact for low income and vulnerable consumers

Direct

LIV consumers can access the benefits of low carbon assets without owning them.

With maintenance and operating cost shared across stakeholders and across the life of the asset, LIV consumers are not deterred by uncertain or unpredictable maintenance costs.

Solutions offering scaled access to assets, for example to multiple properties in a block of flats or on a residential street, may help LIV consumers access benefits sooner than if they waited until they (or another party, e.g. landlord) can install an equivalent asset in the home.

Indirect

LIV consumers and those with whom they co-own these assets could benefit from lower capital costs enabled by the increasing scale and pace at which these technologies are rolled out.

5 Encourage smart-as-standard installations which are easy to use and meet household needs.

Rationale

The increased electricity demand posed by the roll-out of low carbon technologies could add strain to the network if those technologies cannot be operated in a smart and flexible way.

Currently, smart solutions are predominantly adopted by (and tend to be designed for) those who are willing and able to buy and use them. LIV consumers are often less trusting of smart technologies and less confident using them.

LIV consumers (and customers, e.g. landlords who might buy and/or operate smart solutions on consumers' behalf) need to be confident that solutions offer relevant benefits and need to be able to easily and effectively use those solutions to get what they need.

Recommendations

Policy

The existing regulatory framework could be improved so that low carbon technologies are installed in a way that makes them easy for households to use. There are various ways this could be done, from lighter-touch interventions (e.g. issuing guidance on installations) through more involved interventions (e.g. ensuring access to and uptake of suitable training among the installer workforce) to substantial and fundamental changes (e.g. updating buildings regulations).

Stakeholders within and beyond the energy sector should be consulted, drawing on relevant expertise, for example those installing low carbon and/or smart technologies; those with experience installing other technologies and services (plumbing, heating, other fittings) and/or working in LIV consumers' homes; those who may procure and oversee the installation of technologies within homes but are not the end user (e.g. landlords). This expertise should be used to:

- identify and exemplify areas where good practice supports uptake of and full use of smart, flexible solutions among LIV consumers
- understand barriers to LIV consumers using smart, flexible solutions as intended, and identify opportunities for regulation to address these
- explore and define metrics that facilitate the evaluation of the above.

A smart-as-standard strategy for low-carbon technology installations could be developed, with consideration given to how such a movement towards smart-as-standard installations should be communicated to consumers, and who should drive that communication. Implementing such a strategy could focus first on initiatives that facilitate installation of low carbon technologies (e.g. heat pumps) for LIV consumers.

Accessibility standards for digital products and services should be updated to reflect the role that these might play within a smart, flexible energy system.

5 Encourage smart-as-standard installations which are easy to use and meet household needs.

Commercial

Manufacturers should design hardware and interfaces that can be easily installed and used within all kinds of homes and by all kinds of consumers. These should be easy for consumers to use as part of novel propositions that consumers may not yet have experience of using.

Innovators should design communication and support for LIV consumers which reflects their understanding and experience (or lack thereof) of using smart technology and addresses their concerns, to build their confidence in using smart solutions in a flexible way. Innovators should facilitate installers, who may be a key point of contact for consumers, to provide households with suitable training and support.

Impact for low income and vulnerable consumers

Direct

LIV consumers are confident in the benefits that novel propositions offer and can easily and confidently use technologies installed in their homes (including homes that they move into, where smart solutions are already installed) to meet their household needs (including changes in those needs).

Indirect

Consumer support becomes a valued differentiator among novel propositions, playing a key role in consumer purchase decisions or commercial procurement requirements. Innovators continue to invest in developing and refining support.

6 Ensure the benefits and parameters of sharing (and continuing to share) data are clear to consumers.

Rationale

Operating low carbon technologies to deliver consumer and system benefits will rely on increasing volumes, types and sources of data being shared with more types of stakeholders using data within increasingly novel and complex relationships.

If consumers don't share their data, the potential of smart, flexible energy systems won't be realised. If LIV consumers don't take up smart solutions and share their data as part of that, innovation may continue to be disproportionately centred around meeting the needs of, and delivering benefits for, those who are more able and willing to pay and participate.

With increasing reliance on consumer data to appropriately design, cost and operate smart and flexible solutions, there is a risk that LIV consumers unwilling or unable to share their data (e.g. those who are digitally excluded or those living in properties without smart meters) are unable to benefit from these solutions or face greater barriers to doing so.

Recommendations

Policy

Existing data regulations (e.g. General Data Protection Regulation, GDPR; Data Access and Privacy Framework, DAPF) should be reviewed and updated with appropriate regularity and inputs reflecting the pace of innovation in the sector.

Organisations that LIV consumers trust should provide up-to-date guidance that helps them understand how their data is used and how they can benefit from that – particularly with regards to novel propositions – and ensures they understand their rights and how they can control their data. Innovators could be required to highlight to LIV consumers any instances where novel propositions might involve substantial changes to what consumers might understand from their current engagement with the energy market.

A default proxy for consumption data could be established that can be used by LIV consumers unwilling or unable to share their data. This could enable them to understand how they might benefit from novel products and services, for example to understand which propositions may be suitable for their needs and situations and to compare prices. Such proxies could reflect average household consumption for similar households and property types, or an established baseline level of consumption (as set out in the second recommendation). Appropriate guidance must ensure that LIV consumers understand the implications of using proxy vs actual data and can make informed decisions.

Suppliers could be required to demonstrate innovative use of data to better identify and support LIV consumers, including those moving into this group.

6 Ensure the benefits and parameters of sharing (and continuing to share) data are clear to consumers.

Commercial

Innovators should provide sufficient and relevant benefits to encourage LIV consumers to share their data, communicate those benefits in clear and simple terms and ensure the benefits of sharing data are tangible and visible.

Innovators must make it clear who can access and use data and for what purpose, particularly where business models involve the use of new types of data, new relationships between stakeholders and new applications of data.

Innovators must make sure LIV consumers understand how to opt out of smart solutions and the implications of doing so. They should ensure LIV consumers choosing to opt out can do so (and verify that they have done so), for example ensuring there is sufficient provision for those who are digitally excluded.

Impact for low income and vulnerable consumers

Direct

LIV consumers understand how they can benefit from sharing their data and why, how and with whom any data is shared. As a result, they give informed consent.

LIV consumers who are unwilling or unable to share their data have access to a suitable proxy to help them understand how they could benefit from new products and services and make informed decisions.

Indirect

Innovators have continued access to data that helps drive better innovation offering valuable benefits for LIV consumers.

LIV consumers – and consumers whose circumstances change and find themselves in this group – can be better identified and offered suitable and timely support.

7 Ensure regulation and consumer protection keeps pace with an evolving market.

Rationale

LIV consumers can be distrusting of energy suppliers and smart technology. They may be sceptical about novel business models (and the intentions, costs and data involved in those business models). Up-to-date regulation and clear consumer protection could help build trust in new propositions and business models.

With increasing data and digitalisation, and evolving energy markets enabling increasingly more smart solution innovation, it is hard to fully anticipate the changing and emerging risks that LIV consumers might face.

Recommendations

Policy

To ensure consumers are appropriately protected and innovators develop solutions in accordance with consumer protection, there is a need to identify which regulatory frameworks may be relevant to smart solution innovation (e.g. those relating to consumer data, building regulations, accessibility standards) and review whether these are fit for purpose for smart solution innovation. This should include identifying the relevant inputs required for review and the stakeholders best placed to provide those.

Safeguards could be established to prevent propositions incentivising LIV consumers to suppress their energy consumption in a way which may cause them harm (for example, going without heat or hot water).

Commercial

Where novel business models involve aspects that may operate in regulatory grey areas, parties involved in those business models should self-regulate whilst sharing learnings with government and Ofgem.

Impact for low income and vulnerable consumers

Direct

LIV consumers are – and continue to be – willing to take up and use innovative smart solutions. They are aware of their rights and relevant protections and able to act on or draw on these if needed.

Indirect

The consumer data enabled by increasing uptake of smart solutions among LIV consumers is used to inform increasingly relevant and appealing propositions and to evolve regulation and consumer protection in the interests of LIV consumers.

6.5 Summary

The above recommendations form a series of iterative stages, summarised in Figure 6.

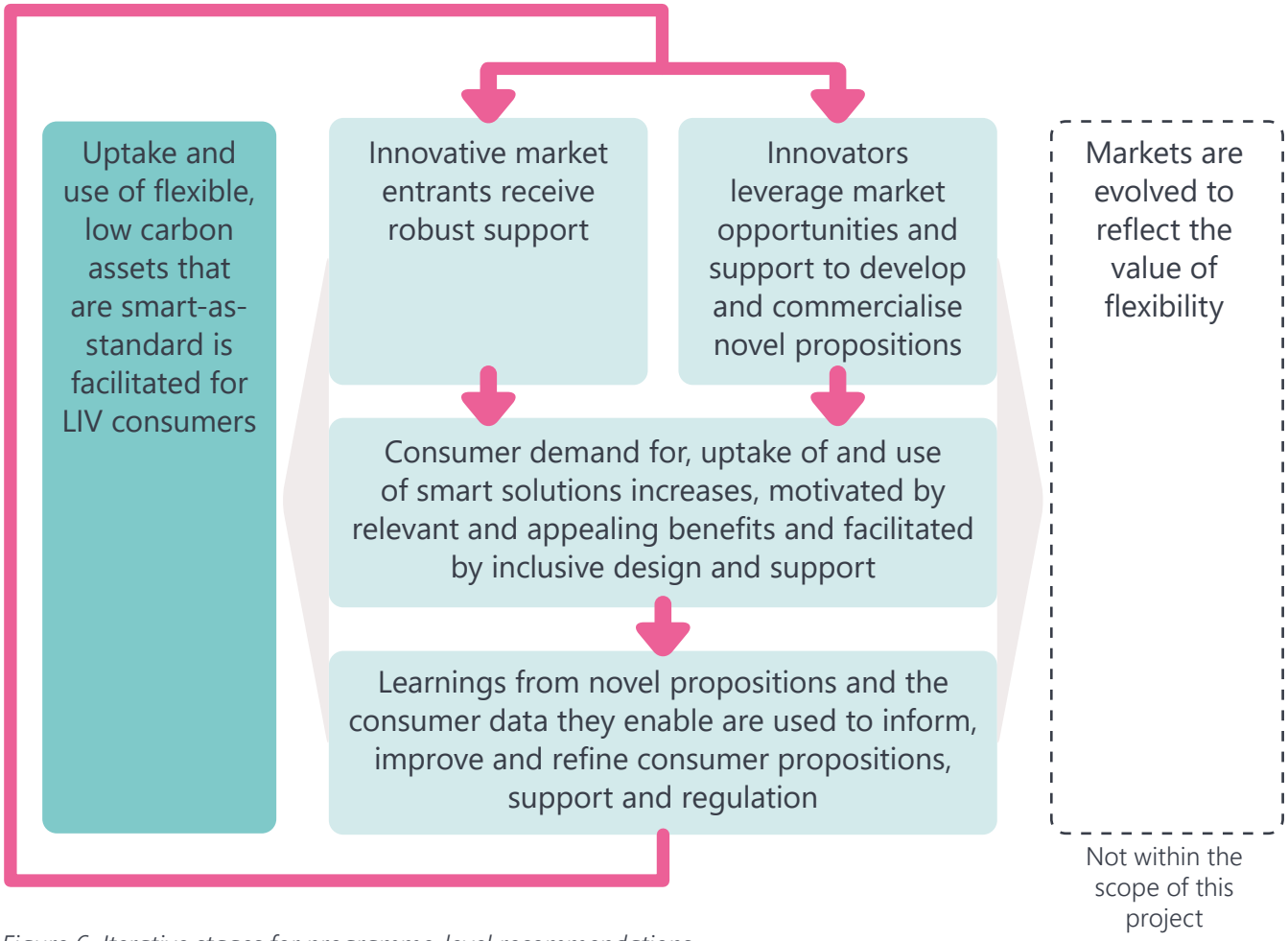


Figure 6. Iterative stages for programme-level recommendations

These recommendations are based on the learnings and insights generated through the research conducted as part of this programme. The following section outlines some of the conclusions and lessons of this programme, and sets out how further research could enable more extensive and expansive understanding of the relevance, appeal and use of smart, flexible solutions among LIV consumers. The recommendations set out here should be further developed and refined based on the learnings of such future research.

7. Conclusions and programme lessons

7.1 What we have achieved

The ISS programme sought to understand the barriers consumers will face in a future, smart energy system (Phase 1), and to develop and refine (up to) four innovative solutions which aimed to tackle these challenges (Phase 2). In meeting these broad aims, the programme has advanced our understanding of how consumers might participate; directly supported innovators in accessing and building consumer, commercial, and regulatory expertise; and provided a blueprint upon which future innovation programmes may be based.

In bringing together project partners with consumer and commercial expertise, and in drawing on LIV Experts by Experience throughout, we have enabled a cross-pollination of ideas and learning. Further, the blended approaches and focuses of innovators within the programme has provided the breadth of insights and implications outlined in this report. The findings from the programme will also indirectly support other innovators in the smart energy sector to refine their approaches.

7.2 What remains to be established

A range of LIV consumers were engaged to take part in research as part of the ISS programme, including Experts by Experience. Together, they represented the LIV groups identified within Phase 1 and prior research. However, participation from renters and those with disabilities could be improved. Whilst we endorse an inclusive approach to design that aims to encompass all consumers, there may be important nuances between different LIV groups in their needs and barriers that could be addressed in a targeted way in future consumer research.

Similarly, the ISS programme engaged stakeholders from across the energy ecosystem, but a more structured approach to stakeholder engagement would be beneficial. In particular, engaging with social landlords using a structured and targeted approach would help to ensure their involvement in future programmes as key players in supporting LIV consumers to participate in smart, flexible energy. Supporting innovators to target this market would help to further an understanding of the barriers specific to this sector. Further engagement with the financing community would also support innovators to understand the financing ecosystem and the range of funding options available to them.

Within each of the ISS projects, there was a focus on consumer awareness along the consumer journey. However, the programme did not focus on wider levels of consumer and stakeholder awareness (e.g. consumer advocacy organisations) across the market. Engagement with future smart energy solutions may require a fuller understanding of levels of awareness across consumers and stakeholders. Moreover, a holistic approach to engagement could be adopted to understand barriers at each stage of the consumer journey (e.g. awareness, agreement, access, adoption[19]), and which stakeholders could be critical to elements of engagement.

7.3 Lessons from the programme

Lessons identified from our experience of designing and delivering the ISS programme may help refine future similar initiatives.

Working across delivery partners and with DESNZ proved an effective means of sharing expert knowledge and collaborating for the purposes of research, but there is scope to improve ways of working within this approach. For example, an agile approach to project delivery would be more effective in adapting to the needs of innovators and responding to required changes as part of the research process. Bringing together 'sprint teams' for the purposes of each development cycle would better enable collaborative and time-efficient working. Bringing together project teams from across the programme also enabled valuable sharing of experiences. Future programmes could aim to establish a more structured approach to innovator and partner engagement.

Consumers played a central role in the research and development of the innovative solutions within the programme. There may be ways to maximise their engagement in future, including paying cash incentives and designing a range of research approaches from the outset, based on the research questions at each stage. Finally, the approach to drawing on Experts by Experience has been justified by the programme, and should be maintained and further progressed for future innovator research and development.

[19] Behavioural Insights Team (2023). How to build a Net Zero society: Using behavioural insights to decarbonise home energy, transport, food, and material consumption. https://www.bi.team/wp-content/uploads/2023/01/How-to-build-a-Net-Zero-society_Jan-2023-1.pdf

Glossary

Key term	Definition
Consumer participation	Consumer access to, purchase and use of (especially 'smart') energy products and services
Energy flexibility	The ability to adjust supply and/or demand in energy
Low income and vulnerable consumers	For this programme, low income and vulnerable consumers includes all energy consumers for whom an accessibility, usability or affordability issue may exist or arise in the transition to a smart, flexible energy system, making it disproportionately challenging for these consumers to benefit from new technologies, markets and business models.
Risky assumptions	Those specific uncertainties which, if investigated, may provide the most impactful research outcomes or insights for commercialisation, as compared with a more general investigation of the wider problem space.
Smart energy markets	The use of data and digitalisation to integrate the actions of consumers and operate energy technologies
Smart energy solutions	Products, technologies and services that enable consumers to engage in a smart energy market, especially those that facilitate flexibility.
Time of use tariff	Tariffs that vary charge rates over time (e.g. nighttime, weekend), typically based on energy demand on the grid.

Acronyms

Abbreviation	Detail
BEIS	Department for Business, Energy & Industrial Strategy
DESNZ	Department for Energy Security and Net Zero
DFS	Demand Flexibility Service
ECO	Energy Company Obligation
LIV	Low Income and Vulnerable
LCT	Low Carbon Technology
MVS	Minimum Viable Service
NESO	National Energy System Operator
Ofgem	Office of Gas and Electricity Markets
RSL	Registered Social Landlords

Department for Energy Security & Net Zero

CATAPULT Energy Systems

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Energy Systems Catapult is an independent research and technology organisation. Our mission is to accelerate Net Zero energy innovation.

Launched in 2015 by Innovate UK, the Catapult has built a team of more than 250 people, with a range of technical, engineering, consumer, commercial, incubation, digital, and policy expertise. They draw on sector-leading test facilities, modelling tools, and data collected from our back catalogue of more than 500 research projects.

We use that 'whole energy' system capability to support innovative companies -- small and large – to test, trial and scale their new products and services. Our impact comes when those innovators attract new customers, new investment, and new grants so they can thrive in the future energy system.

Based in Birmingham, Energy Systems Catapult is part of a network of nine world-leading technology and innovation centres, established by Innovate UK. The Catapult Network fosters collaboration between industry, government, research organisations, academia, and many others to transform great ideas into valuable products and services.

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