Department for Energy Security & Net Zero

Smart Energy Savings Competition (SENS)

Overall impact evaluation report

June 2023

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Rationale for and objectives of the Competition

Smart meters are replacing traditional gas and electricity meters in homes and small businesses across Great Britain as part of an important upgrade to the national energy infrastructure, underpinning the cost-effective delivery of Government's Net Zero commitment. They are a critical tool in the transition to a low carbon energy system, for example helping consumers to use energy when renewable generation is available. Prior to the Competition, BEIS found that smart meters would result in average reductions of 3% for electricity customers, 2.2% for gas credit customers, and 0.5% for gas pre-payment customers[1].

Early evaluation and research have shown that these savings are realised through access to near real time feedback (via In-Home Displays, IHDs), energy efficiency advice at the point of installation, and accurate bills[2]. The Smart Energy Savings Innovation (SENS) Competition was developed on the assumption that more sophisticated uses of energy consumption data can deliver additional savings to those already achieved by having a smart meter installed in the home.

The Smart Energy Savings Innovation (SENS) Competition led by the former Department for Business, Energy and Industrial Strategy (BEIS), committed up to £6.25 million to support the development, trialling and evaluation of innovative feedback products and services that use smart meter data to help domestic consumers reduce their energy consumption. SENS was launched February 2019, with trials concluding end of March 2022 (extended by one-year due to COVID-19 impacts).

The Objectives of the Competition were to:

- Identify innovative products and services using smart meter data that can deliver energy savings in homes, in excess of those currently identified in the smart meter impact assessment, for either the Great Britain population or specific groups within it.
- Ensure that solutions are attractive and valued by consumers and are easily available (using existing technologies and delivery channels or cost-effective new hardware).
- Support the development of a domestic market for energy management products and services, securing investment from technology providers, energy suppliers, and third parties.

[1] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/831716/smart-meter-roll-out-cost-benefit-analysis-2019.pdf
[2] https://www.gov.uk/government/publications/smart-metering-early-learning-project-and-small-scale-behaviour-trials

The SENS Competition comprised of two phases. Following a competitive application process, eight projects were selected and provided matched grant-funding to take their products forward into the first phase of the Competition. During this first phase (June to December 2019), Competition Partners were expected to develop their product or service to a point where it was ready to be rolled out to consumers through large-scale household trials. Phase One therefore included two main workstreams: product development and research; and the design of household trials to be implemented in Phase Two of the Competition.

Following a stage-gate review process, five projects that had reached a suitable development stage were then provided with matched grant funding and taken through to Phase Two, which involved trialling and evaluating their products through large-scale household trials (January 2020 to end March 2022, following a one-year extension due to COVID-19 impacts).

The Competition included a range of different innovative products and services, each utilising novel techniques that utilised smart meter data to generate energy feedback and insights that could induce behaviour change among trialists.

A summary of the five products that were trialled in Phase Two are outlined in the below table:

Project Title	**Competition delivery partner(s)**		**SENS product**
	Lead	**Partner(s)**	
Smart Energy-Smart Thermostat (SEN-ST)	Green Energy Options (GEO) Limited	Shell Energy Retail Limited	A smart thermostat (installed alongside and connected to a smart meter system) that provided trialists with an understanding of their whole home energy consumption, as well as control over their heating and hot water. SEN-ST allowed households to view and control their heating remotely, either through the GEO IHD or GEO mobile application.
Combining Gamification with energy insights to create an energy-saving mobile app	GenGame Limited	Loughborough University Enterprises Limited, Lucid Energy (formerly Intelligent Data Technologies Limited), SO Energy (sub-contractor)	A mobile-only application that used trialists' gas and electricity smart meter data to provide a range of tailored energy consumption information and advice. The GenGame app provided trialists with insights on their historical consumption patterns, forecasted consumption and energy saving advice. It included a gamification feature to encourage engagement.
More Effective and Efficient	Lightbulb ES Limited (parent of	Build Test Solutions Limited,	A three-part package focussed on helping consumers manage their heating use though home performance analytics and

Thermal comfort with Smart meter data (MEETS)	Igloo Energy Supply Limited)	University College London (UCL) Energy Institute	advice, delivered primarily through an online web-based application. Trialists were offered a temperature logger, a personalised household heating report and a package of coaching and tips on more effective heating control.
Smart Local Energy Markets with Smart Meters (SENS Energy Local)	Energy Local Community Interest Company (CIC)	Repowering London, Connected Response Limited, TMA Data Management Limited, Octopus Energy Limited	Energy Local clubs were cooperatives of households who shared access to a local small-scale renewable generator and purchased energy at an agreed price. Trialists had access to a web-based dashboard that brought together their smart meter electricity data, information about available renewable energy and a TOUT, to show households how they could manage their energy use to secure lower costs and use lower carbon energy.
Intelligent Digital Energy Advisory (IDEAS)	Eliq Limited	Bristol Energy (later acquired by Together Energy Limited)	An additional artificial intelligence software feature within the existing 'Be Connected' app. By using trialists' gas and electricity smart meter consumption data, combined with home profile data that trialists submitted in the app, Eliq aimed to create and distribute personalised energy advice for trialists on how they could save energy.

Evaluation approach and methodology

The Competition appointed a Trial Design and Evaluation Lead (TDEL) team, led by Ipsos in conjunction with Energy Saving Trust, Manchester Metropolitan University and the University of Edinburgh to conduct an independent evaluation of the Competition overall, and each of the individual products and services trialled through the Competition.

Separate trial-level evaluations sought to test whether the SENS products were successful in realising their primary objective of reducing energy consumption (either gas and/ or electricity) and what aspects or features of the products made energy savings more likely to occur. There was an ambition to carry out Randomised Controlled Trials (RCT) where possible, however, in practice the most robust and practicable approach was chosen for each trial. These included two RCTs, a quasi-experimental Matched Control Design and two Theory-Based Evaluations.

Data were collected from several sources and analysed for each trial-level evaluation, including: smart meter data on consented trialists' energy use during and before[3] the trial (securely provided to TDEL via the Smart Energy Research Lab based at University College London) and product engagement data. The analysis was supported by a package of wider primary research activities including a baseline and endline quantitative telephone survey with intervention and control group trialists, and qualitative in-depth interviews with intervention group trialists. Several additional focus groups and interviews were also conducted for the Energy Local trial.

TDEL also conducted an overarching evaluation of the Competition level impacts (this report) informed by quantitative and qualitative evidence of the Competition's performance, drawing on a framework that synthesised the outcomes from each trial along with an assessment of product development outcomes. In addition to the trial-level data sources, the Competition-level evaluation also drew on monitoring information and additional qualitative interviews conducted with Competition Partners, sector body experts and delivery partners.

Outcomes for trialists trialling the products / services funded through the Competition

Throughout the Competition lifetime there were several extenuating circumstances that caused challenges in the delivery of each of the trials, related to COVID-19 and the wider retail market. From mid-March 2020, energy suppliers followed safe working guidance during COVID-19 that meant suppliers prioritised emergency metering work and supporting those in hard-to-reach circumstances. While this guidance was relaxed in May 2020 (allowing suppliers to remobilise their smart meter rollouts), some suppliers participating in Phase Two trials faced further challenges in their remobilisation plans. This both reduced the overall number of eligible customers that could be recruited onto the trials and caused delays to funded innovation activities (for example due to prioritisation of COVID-19 response activities).

As a result, trials did not fully achieve the number of recruited customers as initially planned (the expected sample sizes required to detect the anticipated percentage changes in energy consumption). Despite this, analysis of energy consumption data found a statistically significant decrease in gas consumption between intervention group and control group trialists during the trial period for two products (SEN-ST and SENS GenGame); two of the three trials that employed either an experimental or quasi-experimental design), namely an RCT and Matched Control Design respectively).

The energy consumption regression analyses found that SEN-ST smart thermostat intervention achieved a statistically significant reduction in daily gas energy consumption between intervention and controls groups of 5.0% ± 3.9% (95% Confidence Interval, $p<0.05$) for the primary intention to treat (ITT) analysis, while the SENS GenGame intervention found a statistically significant reduction in daily gas energy use of 4.6% ± 2.0% (95% Confidence Interval, $p<0.001$) for those that used the Energy Saver app (Treatment on Treated analyses)

[3] Where pre-trial data was not available via SERL, this was securely provided by the trial Competition Partner.

compared to control group. This was supported by substantial qualitative evidence showing that the change in consumption was attributable to the interventions.

The evaluation of MEETS, the second trial following an RCT approach, was unable to make a robust assessment of energy savings and unable to provide definitive evidence that the product did or did not help trialists to reduce their energy consumption over the trial period. Here, the trial had a lower number of trialists than originally planned, and due to wider retail market challenges with Igloo Energy Supply Retail Limited becoming insolvent, the intervention (especially a coaching component, anticipated to be the primary driver of behaviour change and expected to have the biggest impact on gas consumption savings) was not delivered as intended both in terms of functionality and duration.

Although some Energy Local trialists reported more energy efficient behaviours due to the trial, indicative energy consumption and survey evidence did not show that trialists reduced their overall electricity consumption. There was however evidence that consumers had changed their behaviour to make full use of the electricity supply from local renewable sources available to them and to use electricity at more off peak times (through the Energy Local TOUT) leading to lower electricity bills and increased utilisation of low carbon energy.

While trialists signed up to use the IDEAS product indicatively had lower energy consumption over the trial period compared to before the trial (pre to in-trial descriptive analysis), taken together, the evaluation findings indicated the IDEAS intervention did not contribute towards energy consumption savings. In part due to a change in energy supplier partner, low numbers of trialists had access to the product over a relatively short period of time. As a result, the IDEAS feature could not be delivered as originally planned, with generalised or impersonal tips being provided (rather than the intended tailored or personalised approach), and limited consumer interaction took place.

Across all trials, a critical finding from the evaluation was that the novelty, utility and relevance of energy information presented to trialists was critical. Actionable advice that was tailored to the trialist's household and existing energy usage was one of the most important drivers behind satisfaction and sustained engagement with the product / service. There was weak evidence from the evaluations that presenting already known information in a more engaging way was useful for trialists, except where it was delivered as a prompt or reminder through the SENS product or service. Another critical finding was that the majority of intervention group trialists interviewed said they would recommend the product or service to friends or family members.

Product development outcomes of the Competition

Evaluation findings showed that all Phase One funded projects made progress against their primary product development objectives, reaching high levels of technical maturity during the Competition (ranging from Technology Readiness Level (TRL) 6 to 8, meaning the products were able to be tested in real-world settings). Phase One matched grant funding was seen as valuable in supporting Competition Partners to build relationships with suppliers (i.e. as

potential future customers), to accelerate their product development compared to a 'no funding' situation, and to encourage early engagement with smart meter data at an early stage in the smart meter roll-out.

A primary objective of the Competition was to support Competition Partners to commercialise their products/ services. There was strong evidence presented by Competition Partners to suggest that matched grant funding made available to Competition Partners during Phase Two, to trial products in homes, helped the majority of Competition Partners achieve strong commercial readiness that would allow them to rollout their product more widely.

During Phase One and Phase Two, Competition Partners had already demonstrated some commercialisation outcomes expected at the outset of the Competition, including wider roll-out of products in the form of additional pilot projects and direct sales to UK energy retailers or direct sales to consumers.

The Competition's contribution to wider market impacts

Based on a desk review of products that used smart meter data to provide energy saving advice, the market for these types of products matured from the start of the Competition (in 2018), with the number of available products increasing fivefold (from 3 to 16 products). The evidence base on user acceptance and requirements strengthened; and recent systematic research[4] has shown that feedback tips sent to users through mobile phones, computers and Tablets can help improve energy efficiency and reduce energy consumption.

The wider impacts of the Competition on the market for these types of products were less pronounced. The Competition did not aim to have structuring effects on relevant markets, instead focussing on supporting innovation and evidencing the benefits of products and services that use smart meter data. However, there were signals of market acceptance and acceleration of market entry for a number of the products supported through SENS. Demand for the products and services funded through the Competition was demonstrated by further piloting of products. Acquisitions of GenGame Ltd (lead partner of the SENS GenGame trial) and ONZO Limited (lead partner of one of the SENS Phase One products) (announcements of the acquisitions made November 2021 and September 2021, respectively) demonstrated the commercial appeal of products delivered through the Competition- and offered a wider route to market.

Several factors were expected to encourage wider adoption of these types of products in the future, including likely growing appetite from energy suppliers to provide their customers with low- or no-cost products that help them to save energy while reducing customer churn. Furthermore, consumer appetite for products that can help realise energy and bill savings were expected to rise in the near-term due to rising energy prices and household bills.

[4] I.M. Chatzigeorgiou, G.T. Andreou, (2021). A systematic review on feedback research for residential energy behavior change through mobile and web interfaces. Renewable and Sustainable Energy Reviews, Volume 135.

The Competition also produced significant amounts of novel evidence to inform Competition Partners' further product development of similar services and products, in terms of user requirements and the specific elements of interventions that were valued by consumers. SENS trialists were especially receptive to features that went above and beyond the standard smart meter proposition, such as receiving tailored and novel tips on how to change their behaviour to use less energy, how to reduce heating bills and viewing tailored forecasts of usage to help schedule usage to maximise Time of Use Tariff (TOUT) benefits.

Conclusions

Evidence generated through the SENS competition demonstrated that products using smart meter data to provide energy feedback and advice can deliver additional energy savings for households in addition to those enabled by the baseline smart meter consumer proposition (i.e. a smart meter installation, access to near real time feedback on gas and electricity use via an IHD, and energy efficiency advice delivered at the point of installation).

Two experimental / quasi experimental trials showed statistically significant impacts on gas consumption savings. Across all trials, customer feedback showed there was strong appetite for energy consumption feedback, advice and recommendations to help secure both energy consumption and associated bill savings. Successful trials (that demonstrated energy savings) provided:

- Advice on how to heat the home based on the trialist's real costs / usage (obtained from linked smart thermostats) and offered remote control of home heating systems through a mobile app or an IHD. Through enhanced knowledge and control, trialists were able to reduce the set-point temperature of their property whilst retaining perceived thermal comfort.
- Regular, actionable tailored advice on energy saving measures via an app that led to trialists adopting more energy efficient behaviours that resulted in less heating being used. The gamification feature was also found to improve engagement.

While some projects experienced delivery challenges that prevented their full functionality being delivered or tested, in general (and across all trials) novel, actionable and tailored feedback was valued by consumers. Viewing historical energy consumption was another common and valued feature. Whilst trials may have been biased towards more engaged consumers, there was positive feedback from trialists who valued SENS products (and were disappointed where functionality could not be delivered) and would recommend them to friends or family members.

The Competition also demonstrated a range of additional benefits. One trial provided clear evidence that trialists changed their behaviour to make full use of the electricity supply from local renewable sources available to them and used electricity at more off peak times (through the TOUT) leading to lower electricity bills and increased utilisation of low carbon energy. In general (and across all trials), trialists benefited from enhanced knowledge, awareness, and control.

The domestic market for energy advice/ feedback products (utilising smart meter data) has been supported by SENS but continues to develop organically with growing demand. Several factors were expected to encourage wider adoption of these types of products in the future, including growing appetite from energy suppliers (given wider retail market context), and from consumers to help realise energy and bill savings.

For most Phase Two Competition Partners, there were plans in place to roll out their product more widely, highlighting continued commercial interest in these products and growing user acceptance in the market. Continued innovation and refinement of smart meter data access, including for third parties, will help grow the market further beyond the Competition.

Chapter 1 Introduction

The Smart Energy Savings Innovation (SENS) Competition (from here on referred to as 'the 'the Competition' or 'SENS') led by the former Department for Business, Energy and Industrial Strategy (BEIS) committed up to £6.25 million to support the development, trialling and evaluation of innovative feedback products and services that use smart meter data to help domestic consumers reduce their energy consumption.

Following a competitive application process in 2019, eight projects were selected to receive Phase One Competition (matched) grant funding to support the development of their product/ service. Following a stage-gate review, five projects were taken through to Phase Two (January 2020 to March 2022), to trial and evaluate their products and/or services in homes across Great Britain. The Competition was launched in February 2019, with trials concluding end of March 2022 (extended by one-year due to COVID-19 impacts).

Ipsos, in partnership with Energy Saving Trust, Manchester Metropolitan University and the University of Edinburgh were commissioned by BEIS as the Trial Design and Evaluation Lead (TDEL), to undertake a robust independent evaluation of the Competition, including separate trial evaluations for each of the individual projects, and to implement a wider package of research. Separately, BEIS awarded a grant to the Smart Energy Research Laboratory (SERL) based at University College London (UCL), for the collection and provision of secure access to energy consumption data from trial trialists (with customer consent) to the TDEL for their analyses. Separate to this, BEIS also appointed an independent Project Management lead, AECOM, to oversee Competition Partners' (CP) project delivery and grant funding milestones.

This report is part of a package of evaluation reports published for the Competition, including a Technical Report and five separate trial-level evaluation reports, where details of the SENS innovation projects and their associated Competition Partner Leads (including energy suppliers and third parties), and the outcome of the individual trial-level evaluations, are discussed in more detail.

This overall impact evaluation report includes:

- An overview of the SENS Competition and products funded;
- The evaluation approach and methodology;
- Overall evaluation findings synthesised across the five trials, including outcomes for participants that trialled SENS products and services and product commercialisation outcomes for Competition Partners;
- An assessment of wider market trends for products and services that use smart meter data in domestic properties and indications that Competition funding has supported the long-term development of these markets.

Subsequent chapters of this report provide an overview of the SENS Competition (Chapter 2), after which a discussion of the evaluation approach and methodology follows (Chapter 3).

Chapter 4 presents the overall evaluation findings including the outcomes of trialling smart metering innovation in the domestic sector, the product development outcomes for Competition-funded products/ services and the wider trends observed across the market for products or services that use smart meter data in domestic properties. Chapter 5 discusses the key lessons learnt from the Competition and implications for further market development for products and services that use smart meter data in domestic properties. Finally, Chapter 6 presents key conclusions from the evaluation.

Chapter 2 Overview of the SENS Competition

This chapter provides a short introduction to the Competition, including its core aims and pathways to impact via a Theory of Change, an overview of the products and services developed and trialled across households, and how the Competition was delivered and implemented.

2.1 Context and rationale

Smart meters are replacing traditional gas and electricity meters in homes and small businesses public buildings across Great Britain as part of an important upgrade to the national energy infrastructure, underpinning the cost-effective delivery of Government's Net Zero commitment. They are a critical tool in the transition to a low carbon energy system, for example by enabling incentives for consumers to use energy when renewable generation is available. A key expected benefit of the transition to smart meters is that recorded energy data can be used by consumers to engage with, better manage, and ultimately reduce their energy consumption.

At the start of the Competition (June 2019), over 15 million smart meters had been installed in homes[5] and these were already delivering significant benefits to consumers. In-Home Displays (IHDs), which energy suppliers provide for domestic consumers as part of the smart meter rollout[6], were seen to provide valuable insights on energy use in the home that can prompt the adoption of energy saving behaviours[7]. The IHDs provide "near" real time information on energy costs in pounds and pence, a traffic light view of whether energy use is 'low, medium or high,' and details of historical energy use aggregated into days, weeks, and months. The smart meter installation process for domestic consumers also includes tailored energy efficiency advice at the point of installation.

The Government's evidence base[8] suggests that smart meters are already delivering energy savings for households. Depending on fuel type and whether credit or prepayment, the most recent estimates (September 2019) suggest gross average reductions in demand per household of 3.0% for electricity (credit and prepayment), 2.2% for gas credit and 0.5% for gas prepayment. Recent research[9] also finds satisfaction among smart meter owners is high

[5] Figures include all gas and electricity smart meter installed in domestic properties by large energy suppliers up to and including Q1 2019. Statistics published by BEIS (last updated 26 May 2022), available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1077593/Q1_2022_Smart_Meters_Tables.xlsx

[6] https://www.gov.uk/guidance/smart-meters-how-they-work

[7] Smetherham. J., Hines-Lloyd. A., 2019. The Effectiveness and Consumer Experiences of In Home Displays. Available at: https://www.beama.org.uk/asset/005B90C4-8E04-41B5-B52160A3BA540423/

[8] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/831716/smart-meter-roll-out-cost-benefit-analysis-2019.pdf

[9] https://www.ofgem.gov.uk/publications/consumer-perceptions-energy-market-q2-2021

(71%), with many households reporting benefiting from an increased sense of control from having their energy use made visible to them.

The Competition was developed on the assumption that there is potential for products and services to use smart meter energy consumption data to support consumers in realising additional energy savings over and above the baseline smart meter consumer proposition. A range of potential innovations were envisaged that could leverage households' engagement with smart metering, including the use of analytics to generate tailored feedback, alerts or prompts to drive action, or behavioural insights informed approaches.

At the start of the Competition, the market for products/ services that harnessed smart meter data in domestic properties was nascent, though starting to demonstrate the commercial opportunities for solutions that utilise smart meter data in innovative ways.[10] BEIS highlighted a need to generate robust evidence on the effectiveness of energy insight products in saving energy, their appeal to different audiences and the mechanisms through which behaviour change may be achieved. The Competition aimed to address this evidence gap and deliver on BEIS' Clean Growth Strategy[11] commitment to explore how smart energy data can support personalised recommendations for saving energy by:

- Supporting the development of new innovative approaches.
- Developing a robust evidence base on energy consumption savings.
- Presenting and communicating the conclusions and lessons that can be drawn from the trials and the competition to the wider market, to aid future product and service development.

2.1.1 Wider Context in which Competition Operated (COVID-19 and retail energy market)

The SENS Competition was launched February 2019, with Phase Two trials originally due to conclude end of March 2021. As a requirement of the matched grant funding, successful Competition Partners were required to work with the Trial Design and Evaluation Lead (TDEL) to deliver a trial that would be sufficiently robust in design, delivery and scale, to provide robust evidence on the impacts of the SENS innovative product or service upon domestic energy savings (additional to those enabled by the smart meter roll-out).

It was originally expected that trials would take the form of Randomised Controlled Trials (RCTs), whereby domestic consumers would be randomly assigned to a control or treatment (hereafter referred to as intervention) group. Consumers in the control group would have the baseline smart meter consumer proposition (i.e. a smart meter installation, access to near real

[10] BEIS, 2019. Smart Metering Implementation Programme: A report on progress of the realisation of smart meter consumer benefits. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/830668/smart-meters-benefits-realisation.pdf

[11] BEIS, 2017, Clean Growth Strategy. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/700496/clean-growth-strategy-correction-april-2018.pdf

time feedback on gas and electricity use via an IHD, and energy efficiency advice delivered at the point of installation); and consumers in the intervention group would have, in addition to all of the above, the SENS product or service being trialled.

Trials were also required to be large scale, with sufficient sample sizes (numbers of recruited trialists to intervention and control groups) to detect the anticipated percentage changes in energy consumption and variations among customer segments.

However, in practice the five trial designs recommended and implemented during Phase Two varied in methodological approach. Designs alternative to RCTs, including matched control designs and theory-based evaluations were chosen in trials where these were deemed more practical, whilst still delivering robust and useful evidence. Further modifications were made to accommodate the impacts of COVID-19 and changes in the retail market where required.

From mid-March 2020, in line with government guidance at the time, energy suppliers prioritised emergency metering work and supporting those in hard-to-reach circumstances in their communities. Further to the publication of guidance on safe working during COVID-19 in May 2020, energy suppliers remobilised their rollouts, while implementing additional COVID-19-secure safety measures. Some suppliers participating in the Phase Two trials faced further challenges in their remobilisation plans. As a result:

- Participating suppliers had fewer eligible customers than anticipated at the start of the Competition.
- There were delays to funded innovation activities, for example due to prioritisation of COVID-19 response activities.

In addition, over the course of the project:

- Some SENS Competition Partners lost their energy supply partners due to acquisition or going into administration followed by associated supplier of last resort (SoLR) changes (see trial level evaluation reports for details). Suppliers that went through this process were no longer able to access their customers' energy consumption data to deliver their SENS product, even whilst they remained in the trial. Inability to access energy consumption data meant two projects (MEETS and IDEAS) were unable to deliver their products as originally planned.
- Higher energy prices (during the later trial period) came into effect, with possible associated changes in energy usage and behaviours for trialists across all projects.

As a result of the above challenges, no trial was able to recruit the planned numbers of trialists or complete their activities, within the original trial and evaluation period. In response to this:

- BEIS extended the Competition by 12 months, with trials running up to end of March 2022; all SENS projects applied for and secured a 12-month extension to extend SENS trials (up to end of March 2022), along with extension of the supporting Evaluation and Project Management contracts.

- TDEL revisited research and evaluation activities to mitigate risks and impact upon results, including:
    - Additional work activities and focus to assess COVID-19 context and energy price impacts upon SENS (especially given likely impacts upon energy usage with increased home working).
    - Adapted research data collection methodologies to carry out COVID-19 secure research (e.g. qualitative interviews and focus groups were conducted virtually rather than in person); and,
    - Review of and adapted trial evaluation designs to ensure the most robust approach was used.

Some of the key contextual challenges and changes to the SENS Competition have been broadly outlined. These mean that part of the resulting evidence has to be read with these challenges in mind:

- **Reduced sample sizes for trials**: Despite the extended trial period, trials did not fully achieve the number of recruited customers as initially planned[12]. As such, the Energy Consumption analyses for each trial might not have detected statistically significant energy consumption impacts, due to insufficient sample size/ statistical power (i.e. it missed something that was there) or because impacts were not there to be found.
- **Reduced trial durations**: Some products were trialled over relatively short periods of time compared to the initial aspiration of a year. As a result, evidence may be skewed towards particular times of year (and associated energy use), and under or over-state impacts depending on how consumers engaged with the product or service over time.
- **Evaluation designs**: During Phase One of the Competition, TDEL worked with Competition Partners to design the most robust and viable trial evaluation to provide robust evidence of impacts. Evidence of Competition impacts were further enriched by the package of wider TDEL research activities conducted (including quantitative surveys with trialists, and qualitative interviews with intervention trialists and Competition Partners).
- **Energy price impacts**: Increased energy costs (latterly in the SENS Competition period) may have affected attitudes, behaviours and energy consumption usage unrelated to being a SENS trialist.

The above caveats and implications of these upon interpretation of findings, are discussed in more detail throughout this report and the trial-level evaluation reports.

[12] Calculated by TDEL at start point of each trial, as the sample sizes deemed necessary to detect the expected effect sizes of the SENS intervention upon energy consumption savings.

2.2 Aims of the Competition and how the Competition expected to achieve these

The three key objectives of the Competition were to[13]:

- Identify innovative products and services using smart meter data that can deliver energy savings in homes, in excess of those currently identified in the smart meter impact assessment, for either the Great Britain population or specific groups within it.
- Ensure that solutions are attractive and valued by consumers and are easily available (using existing technologies and delivery channels or cost-effective new hardware).
- Support the development of a domestic market for energy management products and services, securing investment from technology providers, energy suppliers, and third parties.

At the outset of the Competition, a Theory of Change[14] was developed by TDEL to theorise how the Competition would contribute to its short- and long-term outcomes and impacts (presented visually in the logic model in Figure 6 in Annex 1).

2.2.1 Overview of SENS products developed

A range of innovative products that utilised smart meter data were developed by Competition Partners during Phase One, which aimed to make it fun, engaging or easier to save energy at home. Five of these were then taken through to Phase Two to be trialled in households. These broadly covered the following product types:

- **Mobile and web applications** that provided ongoing, tailored energy feedback and advice to the trialist using half hourly smart meter data.
- **Integrated smart thermostats** that accessed smart meter data to provide feedback on the utility and costs of different heating patterns, with remote view and control.
- **Local energy clubs** that integrated local energy generation (e.g. hydro power) with new smart TOUTs, viewed via an online dashboard.

Table 1 below provides a more detailed summary of the five products (and Competition Delivery Partners) trialled during Phase Two.

[13] BEIS, The Smart Energy Savings (SENS) Innovation Competition: Competition Guidance Notes (2019). Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/779452/sens-innovation-competition-guidance.pdf

[14] The Theory of Change sets out the causal assumption of how the Competition would deliver against the core objectives of the Competition, including outcomes and impacts. These are outlined in more detail in the 'Overview of SENS products developed' section of the report.

Table 1 – Summary of products

Project Title	Competition delivery partner(s)		SENS product
	Lead	Partner(s)	
Smart Energy-Smart Thermostat (SEN-ST)	Green Energy Options (GEO) Limited	Shell Energy Retail Limited	A smart thermostat installed (alongside a smart meter installation) that provided trialists with an understanding of their whole home energy consumption, as well as control over their heating and hot water. SEN-ST allowed households to view and control their heating remotely, either through the GEO IHD or GEO mobile application.
Combining Gamification with energy insights to create an energy-saving mobile app	GenGame Limited	Loughborough University Enterprises Limited, Lucid Energy (formerly Intelligent Data Technologies Limited), SO Energy (sub-contractor)	A mobile-only application that used trialists' gas and electricity smart meter data to provide a range of tailored energy consumption information and advice, tailored to the individual customer. It provided trialists with insights on their historical consumption patterns, forecasted consumption and energy saving advice. It included a gamification feature to encourage engagement.
More Effective and Efficient Thermal comfort with Smart meter data (MEETS)	Lightbulb ES Limited (parent of Igloo Energy Supply Limited)	Build Test Solutions Limited, University College London (UCL) Energy Institute	A three-part package focussed on helping consumers manage their heating use though home performance analytics and advice, delivered primarily through an online web-based application. Trialists were offered a temperature logger, a personalised household heating report and a package of coaching and tips on more effective heating control.
Smart Local Energy Markets with Smart Meters (Energy Local)	Energy Local Community Interest Company (CIC)	Repowering London, Connected Response Limited, TMA Data Management Limited,	The creation of Energy Local clubs – cooperatives of households who shared access to a local small-scale renewable generator and purchased energy at an agreed price. Trialists had access to a web-based dashboard that brought together their smart meter electricity data, information about available renewable energy and a TOUT, to show households

		Octopus Energy Limited	how they could manage their energy use to secure lower costs and use lower carbon energy.
Intelligent Digital Energy Advisory (IDEAS)	Eliq Limited	Bristol Energy (later acquired by Together Energy Limited)	An additional artificial intelligence software feature within the existing 'Be Connected' app. By using trialists' gas and electricity smart meter consumption data, combined with home profile data that trialists submitted in the app, Eliq aimed to create and distribute personalised energy advice for trialists on how they could save energy.

Overall, the SENS-funded products and services provided tailored and contextual feedback alongside actionable prompts and recommendations, to support domestic consumers to better engage with their energy consumption and change their behaviour (see Annex 2 for more detailed product descriptions). The products were intended to assist trialists with knowing what to do, being motivated to do it and having the resources to do it (otherwise known as the *Means, Motive and Opportunity* framework)[15]. Some of the core features of the products included:

- "Near" real-time social comparison of energy consumption;
- Personalised style and tone of advice and feedback;
- Targeted periods of change advice;
- Advice which focused on easy-to-change or longer-term behaviours;
- Gamification and matching advice to trialists' motives and circumstances so they were more likely to act.

These features were intended to better inform users of their energy consumption and how to save energy, and help users feel more in control of their energy use so as to improve understanding of future bills. In the short-term (within the timeframe of the Competition), it was anticipated that trialists would adopt more energy efficient behaviours and implement additional energy saving measures in the home where possible. This would then support trialists to reduce their household energy consumption and associated costs and in some cases, achieve greater thermal comfort in the home and also lead to improved household budgeting.

[15] BEIS, The Smart Energy Savings Competition, Potential interventions and how they would have impact. 2019. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/779453/sens-innovation-competition-interventions-and-their-impact.pdf

This report explores the extent to which the anticipated short-term outcomes of the Competition presented here have been realised and which assumptions underpinning the pathways to impact have prevailed.

2.3 How the Competition was implemented

2.3.1 Competition Governance

Key Delivery Partners

The Competition was delivered by the following key delivery partners, and their responsibilities included:

- **BEIS:** the accountable budget holder and sponsor Department for the Competition. BEIS (supported by AECOM) oversaw the Competition, monitoring compliance with grant awards and the delivery of trials. Separately, BEIS oversaw the management of the TDEL contract and UCL SERL grant award.
- **AECOM:** appointed to project manage the Competition, including overall project delivery, managing grant finances, and monitoring project milestones and deliverables.
- **TDEL (Ipsos and its partners):** appointed to work with successful applicants (Competition Partners) to design their trial and monitor its implementation, and to carry out a wider package of research. To then use the findings from this alongside their analyses of energy consumption data collected via UCL SERL to evaluate both individual trials and the Competition.
- **UCL SERL:** responsible for the provision of secure access to energy consumption data from trialists (with customer consent) to the TDEL for their analyses for the evaluation[16].
- **Competition Partners (CPs):** received Competition matched grant funding to undertake product development of their energy savings product / service (Phase One) and to implement their trial (Phase Two), including leading on recruitment activities and rolling out their product to consented trialists.

Overall Governance

The Competition was run by analysts in BEIS and overseen by a Project Board comprised of key BEIS personnel staff and AECOM project management members.

The Project Board provided assurance at key milestones and decision points over the duration of the Competition, drawing on inputs from the project management team (AECOM) and contractors working on the Competition, specifically SERL and TDEL. This included periodic reviews and decision-making of the recommendations for Phase Two grant funding (from prior assessment and moderation by assessors of Phase Two applications) and discussion of key considerations for each trial.

[16] UCL SERL were awarded a grant by BEIS to fulfil these duties.

During Phase Two, the role of the Project Board expanded to also include reviewing updates on trial progress (taking relevant decision or escalating where relevant).

Chapter 3 Evaluation approach and methodology

This chapter provides an overview of the overall evaluation approach and methodology, including each of the trial-level evaluation designs, and the primary research activities conducted as part of the evaluation. More detail can be found in the Technical Report published alongside this evaluation report.

The Trial Design and Evaluation Lead (TDEL) team, led by Ipsos, in conjunction with their consortium partners Energy Saving Trust, Manchester Metropolitan University and the University of Edinburgh, were appointed to conduct an independent robust evaluation of the SENS Competition. This included:

- Conducting an initial assessment of the Competition applications against a set of feasibility criteria (for both Phase One and Two).
- Working with Competition Partners to develop a robust and viable trial of their SENS product.
- Leading a robust evaluation to identify the impact of the trials on household energy consumption and other secondary outcomes, such as perceived energy costs, perceived improved thermal comfort and perceived improved household budgeting.
- Implementing a package of wider research (including conducting primary data collection with Competition Partners, wider sector bodies and domestic customers participating in the trial) to gather self-reported attitudes, behaviours and circumstances related to energy-use. This involved a baseline and endline survey, qualitative interviews and focus groups to assess how key intended outcomes have evolved among intervention group trialists.

More detail on each of these activities can be found in the accompanying Technical Report.

3.1 Evaluation objectives

The purpose of the overall Competition-level evaluation was to create a robust and reliable evidence base around the effectiveness of products and services that used smart meter data to reduce domestic energy consumption.

The primary objectives of the evaluation were to:

- Test whether the products and services piloted during Phase Two of the Competition were effective in realising their primary objective of reducing energy consumption (either gas and/ or electricity);
- Explore the causal mechanisms of changes in energy use;

- Identify how the impact of interventions varies across different customer segments and household types;
- Gather trialists' feedback on using the products and services in areas such as utility, perceived value and overall satisfaction.
- Synthesise trial-level findings at the Competition level and provide assessment of evidence against the key objectives of the Competition.

3.2 Key elements of the evaluation approach

In order to deliver an overarching evaluation of the Competition level impacts, TDEL drew upon quantitative and qualitative evidence of the Competition's impact, using a theory-based framework for evidence synthesis[17]. This review was structured within the context of the Competition's Theory of Change (see Annex 1 for more detail) and assessed whether and how the Competition had achieved the intended short-term outcomes on the market for products that harness smart meter data, and the extent to which longer-term outcomes and impacts might be facilitated beyond the Competition.

Analysis of energy consumption data at a Competition level (aggregated across all trials) was not undertaken, as the individual trials were designed with a focus on internal validity (i.e. ensuring the observed outcomes represented the 'true' situation in the populations involved in the trials). Instead, TDEL synthesised common patterns and findings from trial-level quantitative work where this was sensible.

The design of individual trial-level evaluations, from which evidence was synthesised for this Competition level evaluation, is summarised overleaf in Table 2. It should be noted that all SENS trialists had received the baseline smart meter consumer proposition (i.e., a smart meter installation, access to near real time feedback on gas and electricity use via an IHD, and energy efficiency advice delivered at the point of installation).

Further details on the approaches taken are provided in the accompanying Technical Report. The sources of evidence used to assess Competition impacts are discussed in more detail in the accompanying Technical Report.

[17] More detail on this is provided in the accompanying Technical Report.

Table 2: SENS Phase Two trial-level evaluation approaches

Trial	Evaluation design	Rationale for evaluation design
MEETS (logger, heating report, coaching) (Lightbulb ES Limited)	Randomised Controlled Trial, whereby domestic consumers were randomly assigned to a control or intervention group. Consumers in the control group who had received the baseline smart meter consumer proposition (i.e., a smart meter installation, access to near real time feedback on gas and electricity use via an IHD, and energy efficiency advice delivered at the point of installation) only; and consumers in the intervention group who, in addition to all of the above, were offered SENS MEETS.	There was an ambition to carry out Randomised Controlled Trials (RCTs), considered the gold-standard for studying causal relationships as, through randomisation, they reduce bias and provide a rigorous tool to examine cause-effect relationships between an intervention and outcome. These trials were both deemed suitable for RCT design as they were able to implement both a control and intervention group and recruit sufficient numbers upfront for random allocation.
SEN-ST Smart Thermostat (Green Energy Options (GEO) Limited)	Randomised Controlled Trial, whereby domestic consumers were randomly assigned to a control or intervention group. Consumers in the control group received the baseline smart meter consumer proposition (see above); and consumers in the intervention group received, in additional to all of the above, the SEN-ST product (installed alongside).	
SENS GenGame Energy Saver App (GenGame Limited)	Matched control design, with control group households who had received the baseline smart meter consumer proposition only (see above) and intervention group trialists, who in addition to the above, were provided access to the GenGame Energy Saver App. Intervention group trialists were recruited first. Control group trialists were recruited later in the trial period, though due to UCL SERL collection of historical energy consumption data, the energy consumption data periods were effectively the same for energy consumption	Due to the small recruitment pool at the start of the recruitment phase, the SENS GenGame trial was only able to secure a full treatment group (with access to the intervention over the required period) by recruiting the intervention and control group sequentially.

	analyses. To reduce potential self-selection bias, intervention and control group households were matched via Propensity Score Matching.	
Energy Local (Energy Local Community Interest Company (CIC))	Theory-based design that utilised a realist evaluation approach to testing the primary and secondary outcomes. With realist evaluation, the causal hypotheses were structured as a series of 'context – mechanism – outcome' (CMO) statements in which the aspect of the context (the environment in which an intervention is realised) causes the mechanism to fire, a 'mechanism' refers to the causal process that generates an outcome, and the outcome is any change being measured. This trial involved intervention group trialists only (who received Energy Local, in addition to the baseline smart meter consumer proposition).	Theory-based methods can be used to investigate net impacts by exploring the causal chains thought to bring about change by an intervention. They are suitable in situations, such as for Energy Local, where determining the effect size can often be difficult (including because a control group is not available or feasible), but the intention is to understand whether an intervention had an effect in the desired direction. While theory-based approaches do not provide precise estimates of effect sizes they can provide information on the extent of the change and why the change occurs.[18]
IDEAS feature on app (Eliq Limited)	The trial was implemented as a Theory-Based design, using elements of process evaluation and contribution analysis. The approach involved setting out the attribution problem to be addressed (as detailed in the Theory of Change) and documenting the theoretical assumptions that needed to hold true and external factors assumed to affect the primary objectives of the IDEAS intervention. This trial involved intervention group trialists only (who received SENS IDEAS, in addition the baseline smart meter consumer proposition).	The IDEAS trial was originally proposed to be delivered as a matched control design. However, due to lower than anticipated recruitment the base of eligible customers was deemed too small to follow this approach. For this reason, the design was changed in-flight to a theory-based approach (as the most appropriate methodology to assess the available evidence).

[18] Description of theory-based approaches based upon the HMT (2020) Magenta Book, p43.

3.3 Overview of trial recruitment

Competition Partners' energy supplier partners were responsible for leading on trial recruitment, except for Energy Local who led on recruitment themselves. Recruitment to the trials involved contacting customers and obtaining opt-in consents for their respective trial, using standardised consent form forms in line with TDEL and UCL SERL requirements to ensure they were General Data Protection Regulations (GDPR) and Smart Energy Code (SEC) compliant (see Technical Report for further details). The recruitment approach taken across the trials was tailored to each trial's customer trialist journey in a way that would maximise the number of consents given for each trial[19].

Energy supplier partners recruited trialists (predominantly via recruitment emails) from their customer bases, collecting the various permissions provided by trialists to take part in the trial. Table 3 overleaf provides a summary of the recruitment and retention targets (explained below) and the final recruited and achieved sample sizes in each trial's intervention and control groups. All figures shown represent trialists.

As part of the trial development, TDEL calculated initial recruitment targets, the expected sample sizes required to detect the anticipated effect size of each product (more information around calculating sample sizes can be found in the accompanying Technical Report). The targets were calculated to accommodate anticipated churn over a year (withdrawal of trialists during the trial period) so that the final sample achieved (trialists recruited less any trialists that withdrew due to change of supplier, change or tenancy or active withdrawal of consent) would be large enough to detect the anticipated effect size.

Throughout the Competition lifetime there were several extenuating circumstances that caused challenges in the delivery of each of the trials, related to COVID-19 and the wider retail market. As a result, most of the trials (with exception of the SENS GenGame intervention group), trials did not fully achieve the number of recruited customers as initially planned (and did not meet initial recruitment targets).

The trial retention rates across the trials (proportion of consented trialists that remained in the trial and did not withdraw) was, however, comparatively higher than expected (88% on average across the trials) resulting in higher final achieved sample sizes than expected after initial recruitment had concluded. Nevertheless, with the exception of SENS GenGame, final achieved sample sizes for each trial were still lower than the initially planned retention targets (expected final achieved sample sizes required to detect the expected impact).

As a result of the reduced sample sizes recruited to trials, the energy consumption analyses were likely to have reduced statistical power to detect their anticipated effect sizes. Furthermore, due to staggered recruitment across the trials, intervention group trialists had varied trial length periods that meant some trialists were not exposed to the intervention for long (this was especially the case in, Eliq, MEETS coaching component, and for some SENS

[19] More detail on the recruitment approaches taken can be found in the individual trial-level evaluation reports that have been published alongside this evaluation report.

Energy Local clubs). This was also likely to have influenced the likelihood of detecting their anticipated effect sizes.

Despite this, analysis of energy consumption data found a statistically significant decrease in gas consumption between intervention group and control group trialists during the trial period for two products (SEN-ST and SENS GenGame).

Table 3: SENS Phase Two Trials

Trial	Trial design	Recruitment target (intervention / control) initially set out by TDEL	Recruited to SENS (intervention / control)	Retention target (intervention / control) initially set out by TDEL	Final achieved sample [20]
MEETS (Lightbulb ES Limited)	RCT	1403/1403	932/ 944	1052/ 1052	742/777
SEN-ST (Geo Limited)	RCT	1000/1000	492/ 513	810/ 810	394/ 396
SENS GenGame (GenGame Limited)	Matched Control Design	1435/1435	1912/ 1068	1196/ 1196	1760/1067
Energy Local (Energy Local CIC)	Theory-based (intervention group only)	1180	121	1000	112
IDEAS (Eliq Limited)	Theory-based (intervention group only)	1629	250	1140	245

[20] Consented sample retained at the end of the trial period, accounting for churn of trialists due to withdrawals (Change of Tenancy, Change of Supplier, active withdrawals).

3.4 Primary sources of evidence

The evaluation utilised several data sources at the trial level. More detail on each data source is provided in the accompanying Technical Report. At a high level, these included:

- **A baseline and endline quantitative telephone survey** with trialists conducted between December 2020 and December 2021 (baseline wave) and March 2022 (endline wave). The themes explored included changes in energy saving behaviour, attitudes towards energy saving usage and other secondary outcomes relevant to trials, in addition to if and how trialists had used the products.
- **Qualitative interviews** with a sample of intervention group trialists participating in each trial to investigate their views and experiences of the SENS innovation products. This also included qualitative interviews with several Energy Local Club advisors.
- **Focus groups** with potentially hard-to-reach Energy Local trialists and additional focus groups with Energy Local Club board members.
- **Smart meter data** was collected before and after the trial start date for consented trialists to enable analysis of smart meter data at the trialists level for the evaluation.
- **Product/ service engagement/ interaction data** at the trialist level was collected and shared by CPs to support the analysis of energy consumption.
- **Regular observations of product development and trial implementation activities** through meetings between TDEL and CPs.
- **Project and programme documentation** including monthly reports and other supporting monitoring evidence provided by CPs.
- **Interviews with Competition Partners** were conducted during Phase One and Two to explore aspects of the product design and further development plans, experiences in delivering against the trial design and future commercialisation plans.
- **Interviews with stakeholders representing the smart meter sector** were conducted at the end of the trial period to explore recent developments in the market for products that use smart meter data, drivers and barriers to wider take up of these products and needs of the market to achieve further growth.
- **Interviews with key project personnel** involved in the delivery and oversight of the Competition were conducted to explore the role of the Competition governance arrangements in shaping delivery of the Competition.
- **A desk/ literature review** focusing on the context surrounding the market for products / services utilising smart meter data.

Chapter 4 Outcomes of trialling smart metering innovation in domestic sector

This chapter builds on research conducted under each trial to provide a high-level overview of the factors that supported or inhibited the effectiveness of the products / services trialled in households across GB during Phase Two of the Competition. The chapter gives an overview of how trialists engaged with the products / services and their effects on users' behaviour and whether this was successful reducing trialists' energy consumption.

4.1 Key findings regarding trialist-level outcomes

For two of the three trials that used an (experimental/ quasi) RCTs or matched control design (SEN-ST and SENS GenGame), a robust analysis of energy consumption data found a statistically significant decrease in gas consumption between intervention group and control group trialists during the trial period: The SEN-ST intervention achieved a reduction in gas energy use of 5.0% ± 3.9% (95% Confidence Interval, $p<0.05$) (Intention to Treat analysis), while the SENS GenGame intervention achieved a reduction in gas energy use of 4.6% ± 2.0% (95% Confidence Interval, $p<0.001$) for those that used the app (Treatment on Treated analysis). This is supported by relatively strong qualitative evidence showing that the change in consumption was attributable to the intervention.

While some Energy Local trialists reported they had adopted energy efficient behaviours, indicative evidence suggested that overall energy use was unlikely to have reduced, but with participants prioritising use of cheaper and low carbon energy available from local generation and via a TOUT. In some cases, this may have increased overall energy use, while still reducing costs and leading to increased use of greener energy.

Significant challenges with the delivery of IDEAS and MEETS meant energy savings could not be robustly assessed. While trialists signed up to use the IDEAS product indicatively had lower energy consumption over the trial period compared to before the trial (pre to in-trial descriptive analysis), the evidence gathered, analysed and triangulated indicated that the IDEAS intervention was not causally responsible for this change. No quantitative impact on energy use was found from the MEETS intervention, though (as with IDEAS) small samples and incomplete functionality resulted in any analysis being limited.

Accurate, novel and relevant information presented through the products was the most important factor driving usage across the products trialled: Actionable and useful advice that was tailored to the trialist was one of the most important drivers behind satisfaction and sustained engagement with the product. Novel tips and advice were

similarly important to trialists; simple tips (such as reminders to switch lights off) were more likely to disengage trialists. Low perceived accuracy of information presented to trialists reduced trust in the advice given, resulting in lower engagement with the product.

Some functions of the products / services were more popular than others, depending on the trialist's motivations for joining the trial and their baseline understanding of energy usage in the home prior to joining the trial: Receiving advice and tips on how to reduce energy use in the home, and viewing past energy consumption in the home were some of the most commonly used and more valued features across the products trialled. Low levels of awareness of energy saving behaviours generally led to higher acceptance rates of the tips and advice provided across the products trialled.

Satisfaction with the products at the end of the trial was generally high among intervention group trialists and this was highest in trials where products were delivered in line with their initial expectations: Overall, more than half (54%) of all trialists surveyed at the end of the trial were satisfied (either 'very satisfied' or 'fairly satisfied') with the SENS products trialled. In particular, Energy Local, SEN-ST and SENS GenGame products achieved the greatest levels of product satisfaction (96%, 77% and 62%, respectively) and these were the products that were delivered the most in line with trialists' initial expectations. Trials where satisfaction levels were not as high (IDEAS and MEETS) both faced challenges in delivering their core intervention at scale and for a sustained period of time (see Table 2 in Chapter 3 for a discussion of each trial design and its delivery).

Energy Consumption information using smart meter data presented through SENS products/ services contributed to an indicative increase in trialist knowledge of what used the most energy in the home: In four of the five SENS trials, intervention group trialists' knowledge of what used the most energy in their home indicatively improved over the trial period (an overall 8 percentage point increase in the proportion of trialists reporting an increase between the baseline and endline survey).

The remainder of this chapter sets out the extent to which the products / services engaged trialists, whether and how these products / services led to immediate behaviour change and whether this was successful in reducing trialist energy consumption. The evidence presented against each outcome area is based on a review of the quantitative survey (completed by intervention and control group trialists) and qualitative interviews (with intervention group trialists only) completed across the five trials and the energy consumption analysis at the trial level (see section 3.4 on 'Primary sources of evidence' in chapter 3 for more information on the scope and scale of these research strands).

4.2 Effects of the products / services on trialist energy consumption

The primary aim of SENS products / services was a reduction in trialist energy consumption, achieved through adoption of more energy efficient behaviours or energy saving measures.

This evaluation did not seek to conduct a competition level analysis of energy consumption data (i.e. aggregated across all trials), as the variety in individual trial designs implemented did not allow meaningful analysis of consumption data at the programme level. Instead, TDEL synthesised evidence from across the trial level analysis of consumption data (see individual trial reports for more detail on this) to assess whether the products / services had indeed led to a reduction in energy consumption and if so, to understand why and for what product features.

There was strong evidence that two of the five trials (SENS-ST and SENS GenGame) were effective in realising their primary objective of reducing trialist's energy consumption.

Where robust energy consumption analyses was undertaken (i.e. regression framework analyses), there was evidence of two of the three products achieving significant gas savings, supported by substantial qualitative evidence showing that the change in consumption was attributable to the interventions.

- The SEN-ST intervention achieved a reduction in gas energy use of 5.0% ± 3.9% (95% Confidence Interval, $p<0.05$, Intention to Treat analysis). There was evidence to suggest that through enhanced knowledge of how changes in gas use could lead to energy bill savings, homeowners were more able and motivated to adjust their temperatures with the enhanced controls offered during this trial. This was then effective in encouraging trialists to reduce the setpoint temperature on their thermostats, likely contributing significantly to the achieved gas reductions. The lack of statistically significant reduction in electricity use, demonstrated there were no spill over effects.
- The SENS GenGame intervention achieved a reduction in gas energy use of 4.6% ± 2.0% (95% Confidence Interval, $p<0.001$) for those that use the app (Treatment on Treated analysis). Overall, there was evidence that the range of features in the SENS GenGame app, increased engagement and led to increased understanding of energy use and drivers of energy consumption, which in turn led to measurable reductions in gas use (among those who used the app compared to the control group). Although which behaviour changes and/ or investments directly led to this result was not clear. However, there was no consumption-based evidence that the product led to reductions in daily mean electricity use. The lack of clear effect on electricity use attributable to the app may be partly because, even at the baseline survey, 83% of intervention group respondents (n=355) agreed with the statement "I have tried to reduce the amount of energy I use at home". Although this had indicatively risen to 89% among the endline respondents who had used the app, it implied some energy saving options open to trialists might already have been taken before the trial began, reducing the scope for further electricity saving reductions. This lack of statistically significant reduction in

electricity use may be either because no savings occurred or because any savings were smaller than the trial was capable of detecting.

The remaining trials did not demonstrate any statistically significant changes in energy consumption:

- All Energy Local trialists shared a desire to save energy, either to reduce their negative impact on the environment, or to save money. However, there was no evidence to suggest that the intervention reduced overall electricity consumption amongst most trialists. This was because evidence showed that trialists switched to using electricity at more off peak times (guided by a TOUT) and when available via local renewable sources (i.e. low carbon), which helped to lower their electricity bills, irrespective of the impact on overall usage. There were limitations to the data and evidence available for this evaluation. Recruitment to the individual clubs and the Energy Local trial in general was lower than initially expected. This meant that the sample from which evidence was drawn for this evaluation was relatively limited. The relatively early stage of implementation (i.e. a shorter trial length for some clubs than originally planned) also meant that some of the expected outcomes were not able to be evidenced in full – particularly in rolling the Energy Local model out to potentially hard-to-reach members of the community.
- No detectable effect of the SENS MEETS intervention was observed during the analysis of gas and electricity energy consumption. Many potential reasons could explain these results, including several operational challenges, such as the COVID-19 pandemic (impacting the final achieved sample sizes in the intervention and control groups), changes in the intervention (resulting from Igloo Energy Supply Limited, entering administration) meaning that (due to loss of access to smart meter data from the point of Igloo entering administration) the coaching aspect MEETS could not be delivered as intended. Rather than being provided with tailored coaching advice on how to use products recommended earlier in the project (which was also dropped), trialists were provided generic advice on how to save energy in the home. Interview evidence suggested the advice given was not sufficiently new to trialists and typically confirmed what they already knew and therefore was not that helpful in driving significant behaviour change. Furthermore, this advice was only rolled out to a sub-sample of trialists, thereby reducing the potential for energy savings aggregated at the trial level.
- Indicative energy consumption analysis indicated that trialists signed up to use the SENS IDEAS app had lower energy consumption over the trial period compared to before the trial. However, as evidenced by user statistics, many trialists had limited engagement with the tips and advice feature provided through SENS IDEAS. This indicated no causal relationship between trialists' consumption behaviour and use of SENS IDEAS. These findings are, however, limited by the internal validity of the trial due to SENS IDEAS not being trialled as planned, and due to the low number of trialists. Ultimately, operational challenges, had knock-on effects on recruitment and take-up of the product. As a result, generalised and impersonal tips were provided to trialists, leading to many tips being ignored. Other external factors, such as rising energy costs,

have made it difficult to isolate the effect of SENS IDEAS on some of the primary and secondary outcomes.

4.3 Trialist engagement and product take up

4.3.1 Gaining interest

Trials used a variety of contact approaches in their recruitment, including direct email communications, push notifications through an existing app and/ or a push to web method, whereby trialists were redirected to an online portal where they could sign-up to the trial and provide their opt-in consent. Direct email communications sent by energy suppliers to their eligible customer base were the most common method used to initially contact customers to recruit them to SENS trials. The effectiveness of this method was largely dependent on the trial design and the types of customers being targeted. In four of the five trials, only customers that had previously had a smart meter installed were eligible for SENS recruitment with one trial contacting customers that had not already received the baseline smart meter consumer proposition (due to the need to install the smart meter and the SEN-ST smart thermostat at the same time).

A variety of factors motivated consumers to consent to join SENS Trials:

- **Reduced energy bills:** All CPs marketed their product / service as one that could potentially deliver significant energy savings that may have translated into bill savings for trialists. The notion of lower energy bills was a prominent motivating factor for trialists interviewed. A review of survey data further substantiated this finding with 81% of trialists reporting at baseline being “very conscious about the cost of energy they are using.”
- **Environmental concerns:** Many trialists were driven by the opportunity to play their part in helping the environment through use of products and services that could help to reduce energy consumption. Greater personal responsibility in terms of domestic energy usage was commonly cited as a reason to take part among trialists interviewed.
- **Comparison with other households:** For products that provided social comparisons of energy consumption (MEETS and SENS GenGame), trialists were enticed by the chance to see their relative energy consumption performance compared to similar benchmarked households.
- **A desire to derive additional benefits from smart meters:** The proposition of additional insights drawn from smart meter data beyond what was already provided through a standard IHD was well received by some trialists. This supports findings from previous research which concluded that access to feedback from smart metering would

lead to households becoming more engaged in their household energy use and seeking further information[21].

- **Interest in new technologies**: Trialists that were previously interested in new technologies and showed an appetite to do this again through participation in the trial.[22]
- **Renewable energy at reasonable prices:** The Energy Local offering of local, renewable energy coupled with comparatively lower energy prices was an important motivating factor.
- **Supporting local community:** Energy Local trialists were partly driven by the community aspect of the Energy Local proposition – to consume locally-generated energy. In particular, the ability to financially support other members of the community was an important consideration.

In relatively few cases, interview data found that, the financial incentives used to encourage participation[23] were the driving force behind signing up to the trial (although it is worth noting that sign-up to SENS trials took place before energy price increases).

4.3.2 Engagement with the products / services

The level and frequency of trialists' engagement with SENS products and services were key aspects to understanding the drivers of benefits, and the likelihood of wider take-up of products and services that utilise smart meter data. Overall, most trialists were generally satisfied. Amongst those who responded to this question in the survey, over half (54%) were 'very satisfied' or 'fairly satisfied' with the product, with slightly over a third of respondents (34%) being 'neither satisfied nor dissatisfied'.

A deep dive into the level of engagement by feature helps to better understand the drivers of overall satisfaction with the products and services across the five trials:

- **Getting tips on how to use less energy:** One of the features most commonly used by trialists that had used the product / service were the tips on how to use less energy. A key factor underpinning perceived usefulness (and continued use) of the tips and advice feature was whether the trialist was already demonstrating positive energy saving behaviours before the trial. Overall, 84% of trialists surveyed reported trying to reduce the amount of energy they used at home at the baseline. Further evidence from the qualitative interview data highlighted that trialists with limited awareness of energy saving actions at the start of the trial were more likely to accept the tips and advice provided. However, as was the case for several trialists, many of the tips and product recommendations provided were ones already being implemented. Achieving sustained engagement with this feature was largely contingent on the number of new tips being

[21] Ipsos, Smart Metering Early Learning Project: Consumer survey and qualitative research, 2015. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/407543/3_Smart_Metering_Early_Learning_Project_-_Consumer_survey_and_qual_research_-_Main_report_FINAL_CORRECTED.pdf

[22] As reported by intervention group triallists across all trials during qualitative interviews.

[23] SEN-ST offered a £30 amazon voucher incentive to trialists randomly assigned to the control group. MEETS placed consenting trialists into a ballot in which a randomly selected trialist would be awarded £1,000 off their energy bills. SENS GenGame offered £10 incentives to all (intervention and control) trialists invited to the trial.

offered. Initially, trialists were highly engaged with this feature, though this tapered off over time as the number of tips which were new later diminished. To maintain engagement, trialists interviewed suggested that a staggered rollout of tips would be more effective than providing all of the tips at the start.

- **Seeing how much electricity and gas trialists had used over the last week or month:** Another commonly used feature, trialists were generally positive about the feature enabling them to see how much energy they had historically used in the last week or month (particularly in the wake of increased energy costs). Trialists liked the ability to track and compare historical consumption with other months to observe how changes to their behaviour had impacted their energy consumption. While this is a feature of standard IHDs, it is possible that viewing this remotely through an app provided another channel to view this information. Additionally, trialists liked to see whether they were 'excessively' using gas or electricity. This enabled them to make informed choices about whether to turn the heating down or make other behavioural changes in the property in subsequent weeks / months. Engagement with this feature faded over time for some, as trialists did not feel their consumption patterns were changing regularly enough to warrant regular monitoring.
- **The ability to see how much electricity the trialist was using at that point in time to enable Time of Use Tariff (TOUT) participation:** This was another commonly used feature, among trialists in the Energy Local trial who were on fixed TOUTs, guaranteed for one year by Octopus Energy as part of taking part in the SENS trial. Energy Local trialists could view their energy usage in near real-time, however, information on availability of local generation sources was not available with the same timeliness[24]. Energy Local instead provided forecasts based on previous performance or weather forecast data to inform decisions, however, some consumers wanted the certainty provided by real-time data. Trialists reported that knowing exactly how much energy was being produced in real-time could have driven better engagement with the dashboard so that trialists could run high-consuming appliances during certain times of the day (for instance, when it is raining, for clubs that had local hydro generation) with confidence that they were consuming during periods of abundant local generation. Trialists would have also liked to receive notifications alerting them to when was a good time to consume energy.
- **Getting advice or tips on how to reduce heating bills in the home:**

  Despite only two trials being primarily focussed on heating (SENS-ST and MEETS), getting advice or tips on how to reduce heating bills in the home was a commonly used feature across nearly all trials[25], suggesting heating bills were a concern for homes during the trial period. The survey data supported this hypothesis, with more than 80% of trialists being conscious about the cost of energy they were using at the baseline, indicatively increasing to 93% at the endline. This may however be linked to the timings

[24] There was currently no system set up via Data Controller to access real time generation data (instead with a time lag of approximately one day).
[25] Advice on heating the home for non-heating-based interventions was not informed by actual consumption data, rather, it focused on reminding trialists of the change in seasons and prompting individuals to heat their home less.

of the baseline and endline surveys, with the former taking place in 2021 (prior to the 12% increase in energy price caps in October 2021) and the latter in April 2022[26]. Interestingly, trialists in one of the heating-based interventions (SEN-ST) had the lowest level of engagement with this feature of the intervention. Here, trialists felt they were already making practical choices about their heating prior to the trial starting, potentially explaining why they chose not to engage as much with this feature. The baseline survey data supported this (approximately two thirds of intervention group trialists reported switching their heating off when they left their home for a few hours or switching the heating off in rooms not being used). Another possible explanation that emerged from the interview data was that trialists felt they were not using large amounts of energy anyway and so reducing heating bills was not a significant concern.

- **Carbon savings calculator:** Only one trial product (SENS GenGame) provided information to trialists on how much estimated carbon they had saved due to observed changes in their behaviour. More than half of trialists surveyed (53%) that had used the SENS GenGame app had used this feature during the trial period, substantiating the environmental motivating factor driving sign-up to the trial. While a commonly used feature here, a relatively minor group of trialists interviewed reported they would have valued some additional narrative, such as benchmarking to see how their CO2 savings compared to other households.
- **Heating-specific controls:** In the case of SEN-ST, where trialists were provided a smart thermostat to control their heating, setting a schedule for when the heating came on was the most commonly used feature. This was largely due to the ease with which trialists could control this, by simply pressing two buttons. Trialists were less inclined to make use of functions that enabled them to set gas and electricity budgets or create a schedule for hot water, largely due to perceived inaccurate estimates of how much they had spent on energy. This may also explain why comparatively fewer trialists in the SEN-ST trial sought advice on how to reduce their heating bills through the app.
- **Gamification:** Trialists with access to the gamification feature had positive experiences, often engaging with the levels and challenges aspects of the app in order to accumulate points. Survey data suggested that for a slight majority of SENS GenGame app users, once they had installed and made use of the app and the gamification features within it, those gamification features led to increased engagement. Of the seventy-nine respondents who completed the endline survey and reported having used the gamification features, 56% agreed with the statement "*The challenges and rewards system of the Energy Saver App made me use the app more than I otherwise would have*". As an example, for one trialist interviewed, the points aspect of the SENS GenGame intervention led to further engagement with the app, in particular earning points to enter the raffle for Amazon vouchers.

  "I haven't won one yet but it [points earned through the gamification feature] is an incentive for me. It has affected how keen I am is to use the app because I like to see how many points I have to participate into the raffle."

[26] House of Commons, Domestic Energy Prices, Research Briefing Number 9491. Available at: https://researchbriefings.files.parliament.uk/documents/CBP-9491/CBP-9491.pdf

Several cross-cutting factors also drove usage across the features highlighted above:

- **Accuracy of information presented to trialists:** Low perceived accuracy of information presented to (a minority of) trialists reduced trust in the advice given, resulting in lower engagement with the product / service. The inverse was also true, supporting a key assumption for some of the products trialled: accurate information presented to trialists instilled trust in the information provided that was expected to drive further engagement. Some examples from trialists interviewed include:
    - MEETS coaching emails providing accurate weather forecasts and advice on how to keep the home at a comfortable temperature, leading to further action on coaching messages.
    - Energy costs presented through the IDEAS app were sometimes perceived as not accurate, leading to trialists disengaging with the app in such instances.
    - Similarly, perceived anomalies in the information presented about what consumed most energy in the home (hot water versus electricity) through the SENS GenGame app reduced trialist confidence in the usability of the data provided which led to lower levels of engagement in some instances.
- **Utility/ relevance of information presented:** Actionable advice that was tailored to the trialist was one of the most important drivers behind satisfaction and sustained engagement with the product / service. Some examples included:
    - **Tips:** Most trialists across the five trials found the tips and advice features useful in learning how they could better save energy in the home. Where trials could not provide personalised or tailored tips as originally planned, participants did not find them as useful either because they did not improve understanding on how to change their behaviour, perceived them to be irrelevant, or were already implementing them.
    - **Product recommendations:** Across multiple trials, where trialists were recommended new energy efficient appliances, this was most useful for households who were in a position to make modifications to the household. IDEAS trialists that did find the product recommendation advice useful commonly reported they were already planning on making material changes to their home (i.e. new product installations such as a boiler or LED lighting) prior to receiving the advice. Other trialists considered there was additional research they needed to do prior to making such investments, which were provided via the IDEAS feature. In these instances, the utility of the information provided expedited the process of purchasing these products.
- **Ease with which information was accessed:** The presentation of, and medium through which, information was presented was highlighted as an important factor that affected the frequency with which trialists engaged with the products in general. Some areas that require further consideration include:

- Trialists highlighted pros and cons of mobile and web-based apps, including the requirement to view mobile-app based information on a larger screen, or to view web-app based information on the go (and therefore via a mobile-app).
- A lack of engaging visuals (such as consumption charts) was seen as a barrier to digesting the information presented.
- Colour schemes (particularly in the Energy Local dashboard) made it difficult to read.

4.4 How the products / services increased knowledge

The products/ services trialled were expected to produce a range of Competition outputs (see Competition Level Theory of Change in Annex 1) in the form of attitudinal changes towards how trialists viewed their own energy consumption:

- **Users feel better informed about energy consumption:** The products and services trialled aimed to provide customers with more granular and tailored information about their energy consumption than a typical smart meter IHD.
- **Users feel better informed about how to save energy:** Some products and services highlighted specific ways that trialists could save energy through tailored advice or prompts.
- **Users feel more in control of their energy use and improved understanding of future bills:** Consumer bills might vary significantly over the course of the year as the temperature changes; SENS products and services might contribute to improved understanding of future bills, for example by predicting the anticipated cost of maintaining current comfort levels based on weather forecast information.

4.4.1 Trialists better informed about energy consumption and how to save energy

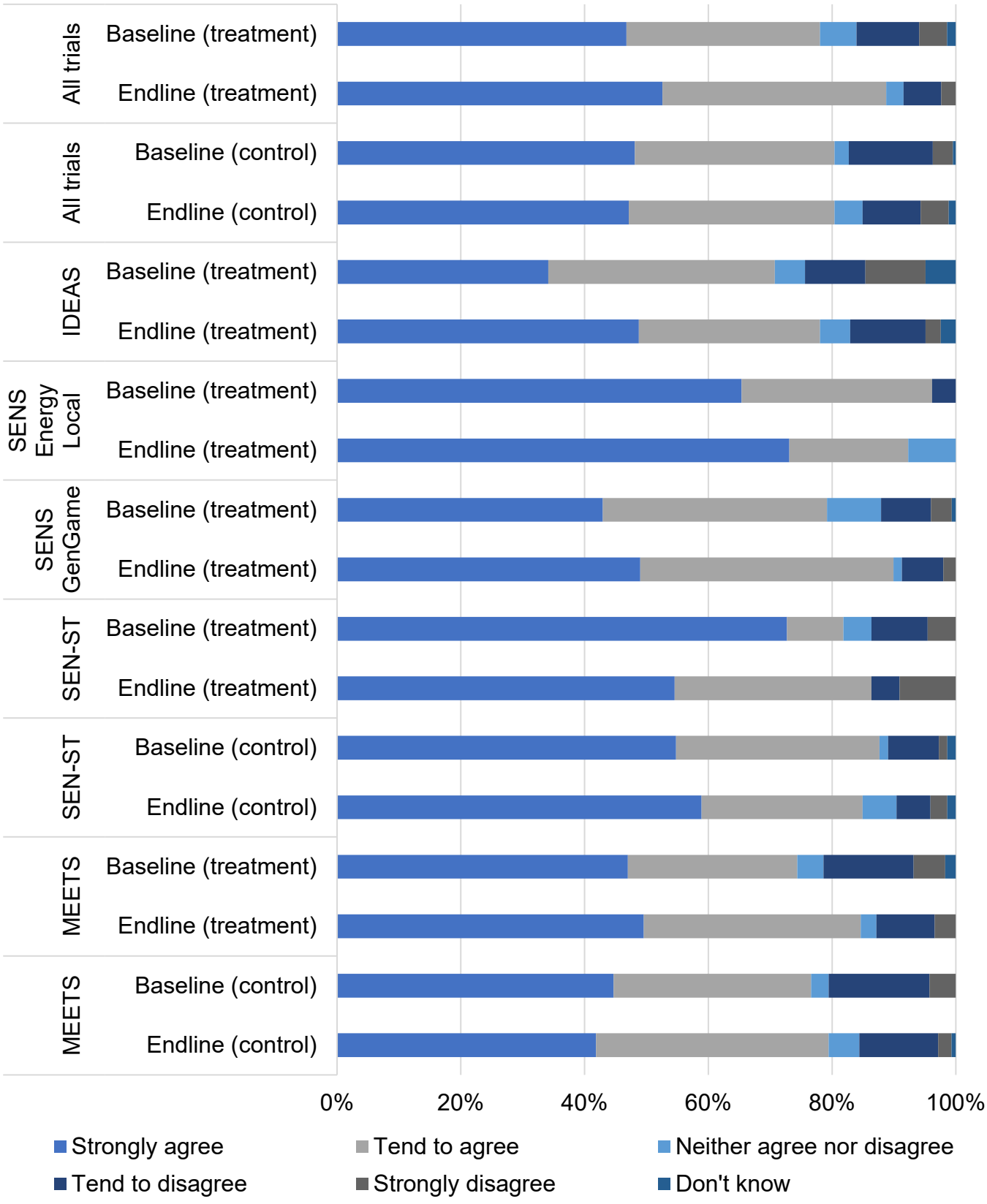
Aggregated across the five trials, intervention trialists' perceived knowledge of what used the most energy in their home improved between baseline and endline significantly[27] (from 78% to 87%*), whereas control group trialists' understanding remained broadly the same (a marginal indicative increase from 80% to 81%). The survey data presented overleaf (see Figure 1) highlighted several key findings:

- The overall proportion of trialists that strongly agreed with the statement "I know what uses the most energy in my home", referred to overleaf in Figure 1 was indicatively higher among intervention group trialists (51% compared with 48% among control group trialists), possibly indicating exposure to the product/ services trialled through the Competition has led to a deeper understanding of which appliances consumed the most energy in the home.

[27] * Indicates the difference in percentages between baseline and endline survey waves was statistically significant at the 10% significance level.

- Some trials had comparatively higher baseline levels of awareness of what consumed energy in the home, notably Energy Local (96%) and SEN-ST intervention group trialists (82%).
- Nearly all trials saw an indicative increase in the proportion of trialists strongly agreeing with the statement “I know what uses the most energy in my home”.
- Where it was possible to compare intervention group trialists with control group trialists (SENS-ST and MEETS), the proportion of intervention group trialists that agreed with the statement indicatively increased comparatively more than control group trialists between baseline and endline. The proportion of SEN-ST intervention group trialist that agreed with the statement indicatively increased from 82% to 95% while the proportion of control group trialists' indicatively decreased from 88% to 85%. Meanwhile, the proportion of MEETS intervention group trialist that agreed with the statement indicatively increased from 77% to 85% while the proportion of control group trialists indicatively increased comparatively less from 77% to 79%.

Figure 1: Percentage of trialists that agreed or disagreed with the statement "I know what uses the most energy in my home."



Bases: All trials: baseline and endline (intervention) 355, baseline and endline (control) 214, SEN-ST: baseline and endline (intervention) 22. MEETS: baseline and endline (intervention) 117. SENS GenGame: baseline and

endline (intervention) 149. SENS Energy Local: baseline and endline (intervention) 26. IDEAS: baseline and endline (intervention) 41.

Looking across the qualitative interview evidence provides further examples of how trialists understanding of energy use had changed:

- **SEN-ST:** Trialists noted insights from the monthly summaries provided through the GEO app were a useful resource to understand monthly consumption patterns, including how much gas they were consuming, and the cost of energy. The GEO IHD was more commonly used as a tool by trialists to understand what appliances were using the most amount of energy. This can be seen in Figure 1 by the increase in proportion of trialists whose knowledge increased over the trial period.

  "Well, it [Geo app] gives me a monthly report about how much I'm using, so that gives me a guide as to how frequently I put the heating on that month."

  "The screen (GEO IHD) shows you your usage, so when it was first installed you do get a little obsessed with that, but a lot of the stuff I had on I needed on so I couldn't turn it off, but it was interesting to see - looking at appliances to see how much they cost."

- **MEETS:** About two thirds of interviewees felt they had a deeper understanding of patterns in their energy consumption at home, due to the use of the logger, and receipt of their heating reports and coaching messages during the trial.

  "The most useful bit about the heating report was the graph with the temperature variation Monday to Friday and weekend. You know, the minimum, maximum and medium. […] I think it's useful to see it and also to see that there is no unusual, bizarre peak anywhere that might be implicating something that was wrong. And also, not too flat suggesting that there is some leakage somewhere."

  "It's [the Lightbulb packaged intervention] helped me to appreciate my energy use more than it did before. Maybe not gone far enough to tell me how to improve it but opened my eyes to what is being used and how I am comparing to others in a similar situation."

- **SENS GenGame:** Among the 15 interviewees, a high proportion mentioned a general increase in awareness of energy use, and what different actions and appliances cost, for one or both fuels. The tips, graphical representations and summaries of energy use and resultant environmental impacts were all mentioned. A range of specific examples of increased awareness were also highlighted by different trialists in the interviews, including: the costs of gas and electricity relative to one another; the costs of leaving things on standby; and, the relative costs of different appliances and behaviours, e.g. heating being the most expensive energy use.

  "It is much easier to see how whatever it is that you do in the house actually affects your energy consumption and your bill in a graphical way and based on the time. It's easy to track. It has made a difference in connecting the dots between your actions, which would like a simple pressing a button on an

appliance or turning on the heating, to how much energy is being used, how your bill goes up and how much more you're destroying the environment."

- **Energy Local:** The survey data strongly suggested that trialists receiving the core intervention improved their overall understanding of energy use (75% of intervention group trialists reported they strongly agreed they knew what consumed energy in the home at endline compared to less than two thirds of interviewees (65%) at baseline). Interview data further corroborated findings from the survey data and provided examples of how understanding improved. The Energy Local dashboard allowed trialists to monitor the consumption of their electrical appliances in close to real time. This often led to various actions ranging from boiling only the necessary quantity of water in the kettle, through to using the oven less often, batch cooking and putting the washing on when renewable energy generation was expected to be high.

  "It has informed us; we realise we don't use a huge amount of energy – [we] tend not to have peaks and troughs…it's quite reassuring."

  "It was the trigger for behaviour change, we started monitoring which appliances would use the most power."

- **IDEAS:** As outlined previously, some trialists in the IDEAS trial did not find the tips novel in terms of offering ways to reduce consumption, leading to low levels of improved understanding on how to change their behaviour in such instances.

  "I can't do anything else; already installed everything possible in the house and already applying all the tips received through the app – none of them [the tips] are things I am not doing already".

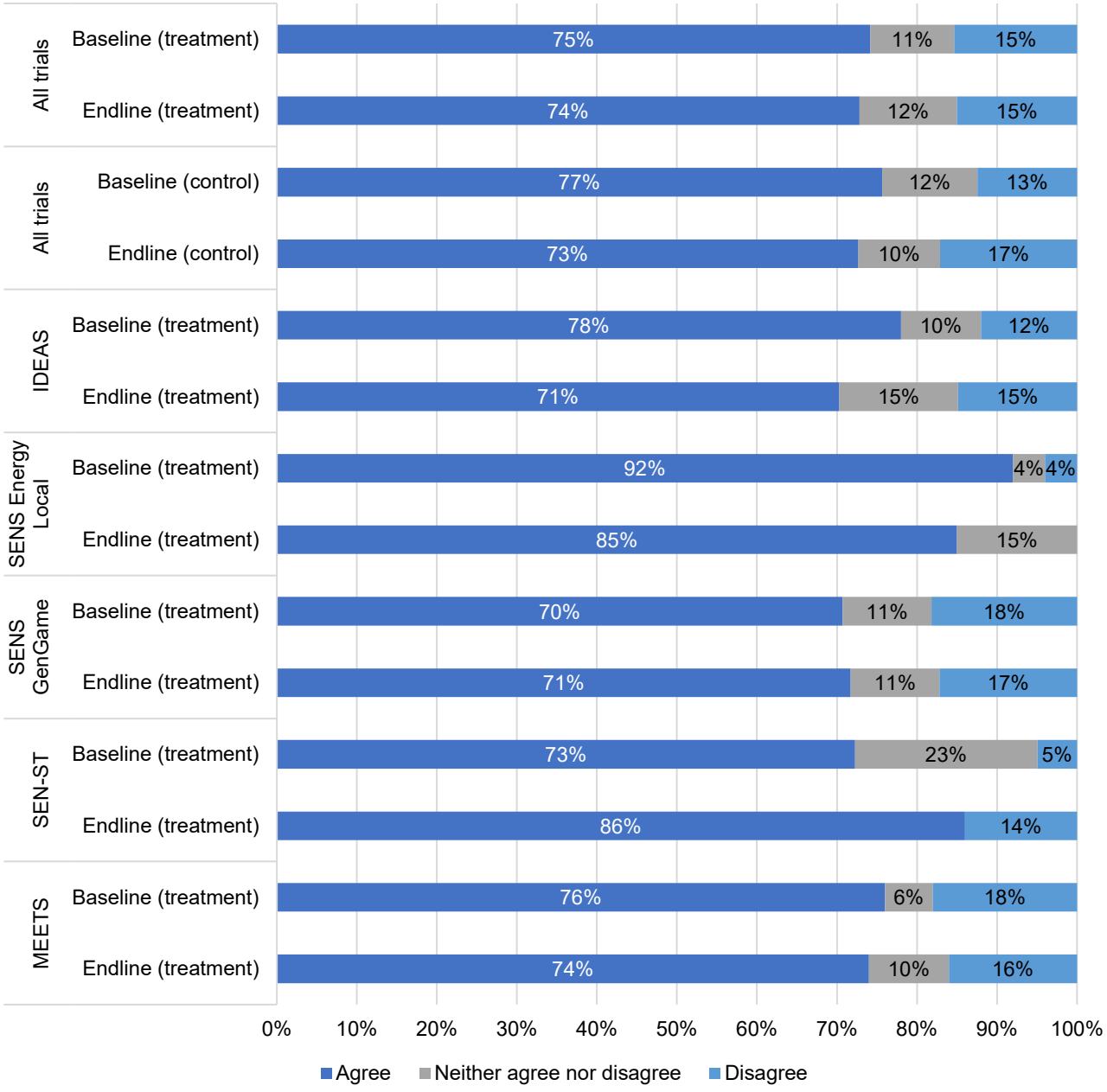
  "I find a bit simplistic, the tips are things I'm already doing, so I wouldn't look at them."

4.4.2 Trialists felt more in control of their energy use leading to improved understanding of future bills

Looking across the five trials, the proportion of intervention group trialists feeling in control of how much energy they use stayed broadly the same between baseline and endline survey (75% at baseline and 74% at endline), while indicatively decreasing for control group homes (77% at baseline and 73% at endline; see Figure 2 overleaf). Evidence across the in-depth interviews suggested that trialists were better able to track their monthly energy costs, but due to rising energy prices towards the end of the trial period (October 2021) tended to feel that any new energy savings behaviours adopted would not meaningfully impact their energy bills. Despite this, trialists found control in other ways:

- Trialists received accurate and up-to-date meter readings through the apps, helping them feel informed and more in control of how they consume energy in the home.
- Forecasts of trialist energy consumption was linked to greater control and understanding of future heating schedule and costs.

Figure 2: Percentage of trialists that agreed or disagreed with the statement "I feel in control of how much energy I personally use."



Bases: All trials: baseline and endline (intervention) 355, baseline and endline (control) 214,.SEN-ST: baseline and endline (intervention) 22. MEETS: baseline and endline (intervention) 117. SENS GenGame: baseline and endline (intervention) 149. SENS Energy Local: baseline and endline (intervention) 26. IDEAS: baseline and endline (intervention) 41.

4.5 How the products / services changed behaviour

Through a combination of more information and greater trust in the information provided, the following outcomes at the trialist level were expected to materialise:

- **Trialists adopt more energy efficient behaviours:** Trialists were expected to make use of the information presented by the SENS products and services, including making use of specific advice prompted by the product, to change their behaviours. For example, this may include reduced use of heating while the property is unoccupied.
- **Increased demand for additional energy saving measures:** Based on the advice received and an increased understanding of their energy consumption, trialists were expected to consider implementing energy saving measures in their home, such as replacing appliances with more efficient alternatives, or installing insulation or double glazing.

The extent to which these outcomes materialised are explored below.

4.5.1 Effects on energy use behaviour

Generally, as shown in some of the trial-level evaluation reports, there were indicative increases reported by intervention and control group trialists between baseline and end line survey waves in adopting more energy efficient behaviours, though to varying degrees depending on the behaviour reported against.

A review of in-depth qualitative interview data across the trials highlighted some examples of trialists adopting energy efficient behaviours:

- Putting warm clothing on during colder days, rather than switching the heating on for longer.
- Running the washing machine at full capacity, rather than at half loads.

  "I'm making sure the washing machine has a full load, turning the heating off if not in use – it's the same with radiators."

- Running the dishwasher at a lower temperature.

  "My wife washes at a very low temperature and we use the eco button, overnight. We [also] do not have a lot of lights on."

- Lowering the temperature of the shower.
- Draught proofing the home.
- Turning off the oven ten minutes before the food is cooked.

  "[We] use a slow cooker instead of the oven or we turn the on the oven only. We [also] turn it off ten minutes before the food is cooked."

Trialists who did not take action based on energy saving recommendations explained this was because of:

- Limited understanding of how the energy saving tips would lead to reductions in usage. For example, one trialist was recommended to use the 'eco' mode on their washing machine. However, once they found out the wash lasted for three hours, they

questioned the advice given and chose to use the standard settings on the washing machine.

"[I] tried to use Eco mode on the washing machine but it takes 3 hours! How is that more eco? I just use the standard settings instead."

- Novelty of the advice given was not sufficient in encouraging trialists to adopt 'new' behaviours. This was particularly important as many of the trialists across the intervention groups were already demonstrating positive energy saving behaviours and making active choices to reduce their energy consumption prior to using the product / service.

  "[We] understand them reasonably well, but what more can we do? Already washing at 30 or 40 [degrees], have low energy bulbs, hang washing rather than use tumble dryer. [We] feel helpless sometimes."

  "I'm very savvy about things. What they might tell me, I might already be doing or have it in place. Can't see how I can logically reduce my energy usage."

- Inconvenience associated with making any changes to the behaviour. For example, trialists that were recommended to change their heating settings from one day to the next found this to be a strain, particularly as they did not have any smart heating controls that would allow them to do this as easily as those with enabling technology.

  "It's a gadget. But it doesn't help. I got it out of curiosity. I couldn't be bothered to keep changing the heating regime."

4.5.2 Effects on investments in energy saving measures

There was some limited evidence that trialists exposed to the products / services had installed additional energy saving measures in their homes over the trial lifetime, however, the trials were often delivered over a limited time period compared to the initial aspirations of a year.

Therefore, while MEETS, SENS GenGame and Energy Local provided advice and information to trialists about the benefits of installing energy efficient measures in the home, the limited duration of these trials meant significant investments were unlikely.

There was, however, evidence of the products / services playing an important role in trialists' purchasing decisions among the trialists interviewed. Several trialists interviewed reported having installed energy saving measures in the home as a result of the advice provided through the product/ services. For example, installing new boilers, cavity wall insulation, thermostatic radiator valves, LED lightbulbs and double-glazed windows in the home.

"I think it [MEETS] has probably changed my behaviour in terms of making purchasing upgrades. The heating report helped confirm some of my purchasing decisions that I had been contemplating, such as the new boiler and double glazing on one of my windows."

While the evidence suggested positive acceptance of the recommendations provided through the products / services, some trialists were deterred from purchasing such measures due to high investment costs and long payback periods.

4.6 Effects of the products / services on trialist thermal comfort and budgeting

In addition to helping trialists achieve energy savings, CPs aimed to deliver a number of secondary benefits to trialists of utilising the features offered through the products / services, including having more comfortable homes and improved household budgeting.

4.6.1 Improved thermal comfort

A number of mechanisms were expected to lead to improved levels of perceived comfort within homes:

- **Reduced wasteful energy consumption resulting in more efficient heating of the home:** If, for example, trialists only heated their home when it was occupied, when previously it was heated while unoccupied, they may find they can afford to heat it to higher temperatures but for less time than before, resulting in more comfort.
- **Easier control of heating system through the use of enabling technology:** This pathway was specific to the SEN-ST trial in which trialists were given access to smart heating controls coupled with energy saving tips that enabled trialists to become more comfortable in their home. This included ensuring that the property was always heated to the appropriate temperature when people were in the house and changing thermostat settings to ensure that the level of comfort was achieved.

A review of the quantitative survey and interview evidence from across the trials appears to suggest that the products / services have not led to any major changes in the way that trialists heated their homes in order to improve their overall comfort levels. Instead, this was likely a result of most trialists already heating their home to a comfortable temperature at the start of the trials.

The overall proportion of intervention group trialists that agreed with the statement: “During the Winter, I am usually able to keep my home at a comfortable temperature”, indicatively decreased between baseline and endline survey waves (from 91% to 86% respectively). This suggests the products and services did not have any positive significant effect on improvements to home comfort levels. In comparison, over the same period, the proportion of control group trialists that agreed with this statement remained the same. These findings could be contextualised by the following:

- Increasing energy costs towards the end of the trial period may have made it expensive for occupants to keep their home to a comfortable temperature. Though the proportions of both intervention and control group trialists who found it too expensive to heat their home indicatively increased between baseline and endline, this was more exaggerated

across control group trialists. The proportion of intervention group trialists that self-reported it was too expensive to heat their home to a comfortable temperature increased from 18% to 30%[28], Meanwhile, the proportion of control group trialists increased from 15% to 31%[29].

- The proportion of trialists across both groups that reported leaving the heating on when they go out for a few hours indicatively increased over the trial period, which may have lessened the potential savings that could be reapportioned to making their home warmer during occupied hours. Trialists became more concerned with saving energy than keeping their home warm and comfortable.

4.6.2 Improved household budgeting

Certain aspects of the Competition-funded products / services were intended to provide additional information about energy costs, including current and forecasted expenditure amounts on energy, based on current energy consumption levels and weather forecasts. This was intended to better enable trialists to budget their household expenditure.

A review of the quantitative survey and qualitative interview evidence from across the trials appears to suggest that the products / services did not enable better household budgeting practices.

Across two of the three trials where improved household budgeting was an expected secondary outcome, via a budget function on the product or via enabling tracking of energy consumption and expenditure (SEN-ST and SENS GenGame respectively), the proportion of trialists that found it difficult to predict how much they would spend on household energy each month indicatively increased between baseline and endline survey waves, despite the majority of trialists (81%) already being conscious about the cost of energy they were using at the baseline. The drop in measure of household budgeting (the proportion of trialists that monitored what they spent on energy against a budget, indicatively decreased from 60% to 56% between survey waves) could be reasoned by:

- **An indicative drop in the level of control trialists felt they had as regards to how much energy they used over the trial period.** Evidence from across the in-depth interviews (conducted in February and March 2022) suggested this could be because rising energy prices (occurring in October 2021) made it difficult for trialists to link energy saving actions with realised bill savings.
- **How well trialists managed their energy bills.** Most trialists (82%) surveyed at the baseline (conducted between December 2020 and December 2021, with exact dates varying by trial) were managing well with their energy bills at that moment in time, possibly diminishing the need to track their energy costs and closely follow budgets on a weekly or monthly basis during the trial period.

[28] Statistically significant increase at $p<0.05$.
[29] Statistically significant increase at $p<0.05$.

- **Wider contextual factors.** The increase in energy price caps was likely to have made it more difficult for trialists to predict how much they would spend on energy each month.

4.6.3 Increased use of low carbon energy and reduced bills (Energy Local)

The Energy Local intervention aimed to increase use of low carbon energy from:

- Local renewable generation (e.g. wind, solar or hydro) provided through a fixed price contract.
- A TOUT that provided cheaper rates for off peak energy (which is also more likely to include a higher proportion of renewable energy).

Qualitative evidence collected from participants suggested that Energy Local had been successful both in increasing knowledge about why peak energy consumption might be more expensive and enabling trialists to use a greater proportion of non-renewable energy. As part of this, it also helped trialists to move their consumption to times of day that would maximise usage of lower carbon energy.

There was also evidence from the qualitative depth interviews that Energy Local club members experienced a drop in their electricity bills compared to the pre-trial period, which they attributed to the intervention, specifically due to being given access to local energy generation at a fixed price, and TOUT price tariffs, guaranteed by Octopus Energy for one year.

4.7 Assessment of the Competition Theory of Change

The Competition Theory of Change developed by TDEL at the outset of the Competition (see Annex 1), hypothesised that trialists could achieve an overall energy consumption reduction through frequent and meaningful engagement with products that provide energy feedback services. On-going, tailored information and data on energy usage and feedback was expected to better inform users how they consume energy in the home and how they could take manageable steps to reduce their consumption while also feeling more in control of their energy use. The key assumptions underpinning this were that the advice and recommendations provided to trialists were relevant and appropriately tailored to the household context, and that individuals were able to correctly interpret and act upon the advice provided. Consumers were then expected to be more likely to act on the feedback and advice given.

This evaluation found evidence drawing from the energy consumption analysis, quantitative survey and qualitative interview data to support elements of this theory within each of the trials. Table 4 below and the preceding sub-chapter ‘outcomes for trialists’ outlines that within four of the five trials, trialists received information through the products/ services that raised their overall understanding of energy use in the home and ways to change their behaviour to reduce their household energy consumption. In two of the three trials that followed an experimental/ quasi-experimental design, there was clear evidence that the products / services had already led to energy savings at the trialist level.

There are, however, other key dependencies which were not recognised from the outset. Both sets of assumptions are presented and explored in Table 4 below. Both the initial and a revised Theory of Change of 'what actually happened' are provided in Annex 1. The main differences relate to the assumptions needed for the pathways to impact to fire (see 'Other dependencies not identified at the outset of the Competition' in the table below).

Table 4: Factors underpinning the Theory of Change

Assumptions identified at the outset of the Competition	
Assumption	Assessment
Solutions provide new information to users, or known information but in a more engaging or applied way	A critical finding from this evaluation is that the novelty and utility/ relevance of the information presented to trialists was of high importance in encouraging action to be taken. Actionable advice that was tailored to the trialist was one of the most important drivers behind satisfaction and sustained engagement with the product / service. According to the evaluation, presenting information in an engaging way was not helpful to trialists if they already knew the content/ advice, except when it was delivered as a prompt or reminder through the SENS product/ service. An example emerged from the MEETS trial in which trialists were reminded to alter their set-point temperatures due to changes in external weather data. While they knew to do this already, some trialists found the email/ message a useful reminder.
Advice/ information needed to be trusted and actionable	As outlined in the preceding sub-chapter ('Trialist engagement and product take up') the evaluation found that this assumption was valid across the products / services. Low perceived accuracy of information (for example abnormally low-cost estimates of monthly energy consumption) presented to trialists tainted trust in the advice given, resulting in lower engagement with the product / service. The inverse was also true, supporting a key assumption for some of the products trialled: accurate information presented to trialists was expected to instil trust in the information provided that was expected to drive further engagement.
Solutions encourage more energy efficient behaviours and/ or increased demand for energy saving measures.	In most of the trials, intervention group trialists' knowledge of what used the most energy in their home improved over the trial period. This was noted to be in part because of the information presented through SENS products where this was a core feature. Trialists were more likely to act on the advice given when the tips and recommendations were novel, easy to implement and the energy saving potential of the action was well explained to the trialist.

Users are able to observe impact of changes made to their energy use behaviours through their energy bills	The evaluation found that the majority of trialists interviewed did not perceive any reduction in their energy bills. This may have been due to an increase in energy prices (also recognised by trialists), that offset any reductions in bills that might have been induced through energy saving behaviours. The exception to this was Energy Local in which there was evidence from the qualitative interviews that Energy Local club members experienced a drop in their energy bills due to the intervention and the fixed tariff guaranteed by Octopus Energy for one year.
Other dependencies not identified at the outset of the Competition	
Staggered rollout of tips	Feedback from trialists suggests that a staggered rollout of tips over a prolonged period was more likely to encourage sustained engagement with the product / service.
Advice is appropriately tailored to the trialist	The utility of the advice given was largely dependent on the relevance of the advice to the trialist's situation. There was clear evidence of some tips being provided to trialists that were not actionable. For example, recommending wall insulation in a terraced property or giving heating advice to trialists to switch their heating on sooner when they instead have only underfloor heating that is continuously on due to the time it takes to heat up.
Clearly explaining how / why actions lead to energy savings	There was some qualitative evidence to suggest that limited understanding of how the energy saving tips would lead to reductions in usage over time. Improving this aspect of the advice could potentially raise trialists' understanding further of what consumes energy in the home that could lead to further behaviour changes and energy reductions. This would require further testing to validate this hypothesis.

Chapter 5 Product development outcomes of the SENS Competition

This chapter provides an assessment of the impacts of the SENS Competition in accelerating the development and commercialisation of products and services funded through the Competition. This chapter draws on project monitoring data and interview data with Competition Partners.

5.1 Key Findings

There was a strong sense among Phase One Competition Partners that Competition funding had helped to accelerate the development of their SENS products compared to a Business as Usual scenario (BAU): Phase One (matched) grant funding supported Competition Partners to make progress against the majority of their product development objectives and reach high technology readiness levels (ranging from TRL6 to TRL8; see Annex 3 to view the Technology Readiness Level scale), to the point where they were able to test their innovation in real-world settings during the Phase Two trials. The factors enabling accelerated product development included (provided in more detail below): ability to hire new staff; engage early on with smart meter data; form collaborations in academia and other private sector organisations; and dedicate resource to develop products that were perceived as riskier than other assets.

According to Competition Partners, Phase Two funding was important in undertaking large-scale trials at reduced costs to Competition Partners that otherwise may not have occurred at that time: Phase Two funding was seen as useful by most Competition Partners interviewed in undertaking larger and more rigorous product testing, fostering collaboration with key consortium partners and overcoming any further product development work necessary. This helped the majority of Competition Partners progress the commercial maturity of their product / service to a point where they could start to roll-out their product more widely. Learnings from these trials have enabled CPs to scope route-to-market strategies and start selling their product externally outside of the SENS Competition.

There were already signals of market acceptance (defined as whether the product or service was satisfying a need of a large customer base) and demand for the products and services funded through the Competition: The acquisitions of GenGame Ltd and ONZO limited (announcements of the acquisitions made November 2021 and September 2021, respectively) demonstrated the commercial appeal of products delivered through the Competition. The SENS GenGame Energy Saver App has been able to demonstrate its value in supporting the acquiring company, Chameleon Technology, to deliver a platform for intelligent and optimised control of their energy at

home using real-time energy data insights. GEO's acquisition of ONZO will allow it to use ONZO's energy disaggregation technology to enhance its Whole Home Optimisation capability. While the core technology driving the acquisition is not one initially developed during the Competition, it nonetheless indicates appetite from market actors for services that provide machine learning capabilities that utilise large amounts of smart meter data to deliver benefits for households. Furthermore, four of the five Phase Two Competition Partners were expecting to continue to roll-out their product beyond the lifetime of SENS, including further product trials and direct sales to UK energy retailers.

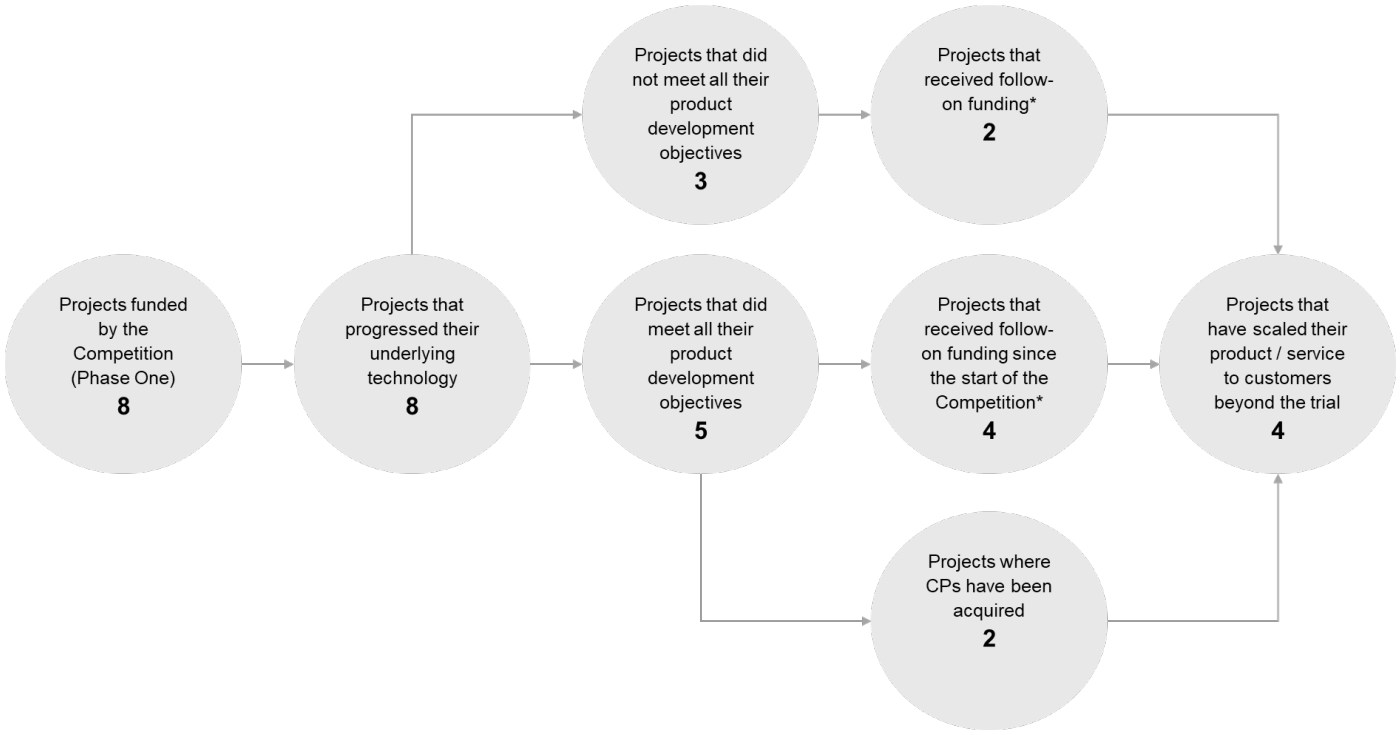
Competition Partners highlighted several external factors affecting their ability to effectively commercialise their product beyond the lifetime of SENS: There was tension over the expected effects of the recent consolidation of the UK energy retail market. Competition Partners highlighted the potentially negative impacts of a smaller market to which they could market and sell their product to, coupled with reduced customer switching between suppliers (an onset effect of the consolidation) that could reduce the incentive for suppliers to offer energy saving products to their customers. Nevertheless, some believed the current market conditions and recent energy price increases gave further impetus to SENS related products that could deliver energy and bill savings. Separately, the ability to sell products was linked to the base of smart meter households; installation of smart meters was curtailed at times during 2020 and 2021 as suppliers complied with COVID-19 restrictions. While installations have subsequently increased, and 55% of households now have smart meters[30], the pool of households that could utilise the products / services trialled through the Competition was lower than it would have been otherwise.

Figure 3 below provides a visual overview of the key product development and commercialisation outcomes among SENS Phase One and Phase Two projects. The key findings were as follows:

- All Phase One and Phase Two projects progressed their underlying technology.
- Of those, five projects met all of their product development objectives (set by the projects themselves at the application stage), while three projects met some but not all of their objectives.
- Of the three projects that did not meet all of their product development objectives, two of these have raised equity funding since the start of the SENS Competition.
- Of the five projects that met all of their product development objectives, four have raised equity funding since the start of the SENS Competition. Two of the projects have since been acquired.
- Half of all Phase One and Phase Two projects have been able to scale their product / service to customers beyond the trial.

[30] https://www.gov.uk/government/collections/smart-meters-statistics

Figure 3: Overview of commercialisation outcomes among SENS projects



Source: Interviews with Competition Partners and review of project documentation.

Definitions provided in the footnote below. [31]

5.2 Accelerated development of sponsored products / services utilising smart meter data

As discussed previously, the core objective of the Competition was to support the development of a domestic market for energy management products and services. To achieve this, the Competition funded eight projects during Phase One, during which projects were required to build and integrate the various features of their product / service to the point where they could be trialled in homes at scale across Great Britain during Phase Two.

[31] Projects were deemed successful in progressing their underlying technology where they were able to progress along the technology readiness level scale during either Phase One or Phase Two of the project.

Projects were deemed successful in meeting all their product development objectives where they were able to successfully deliver the core development objectives identified at the outset of the SENS Competition.

Projects that needed to adapt their product or did not meet their original product / service specifications were classified as 'did not meet their product development objectives'.

Projects were deemed successful in scaling up their product / service to customers beyond the trial if they had, at time of interview, already secured contracts with customers/ suppliers to rollout their innovation more widely.

* None of the private fundraisings (labelled in Figure 3 as 'follow-on funding') identified were linked to the development or rollout of the underlying SENS innovation and therefore cannot be attributed to Competition funding. One project achieved public follow-on funding to further optimise their innovation and test this within real-world homes.

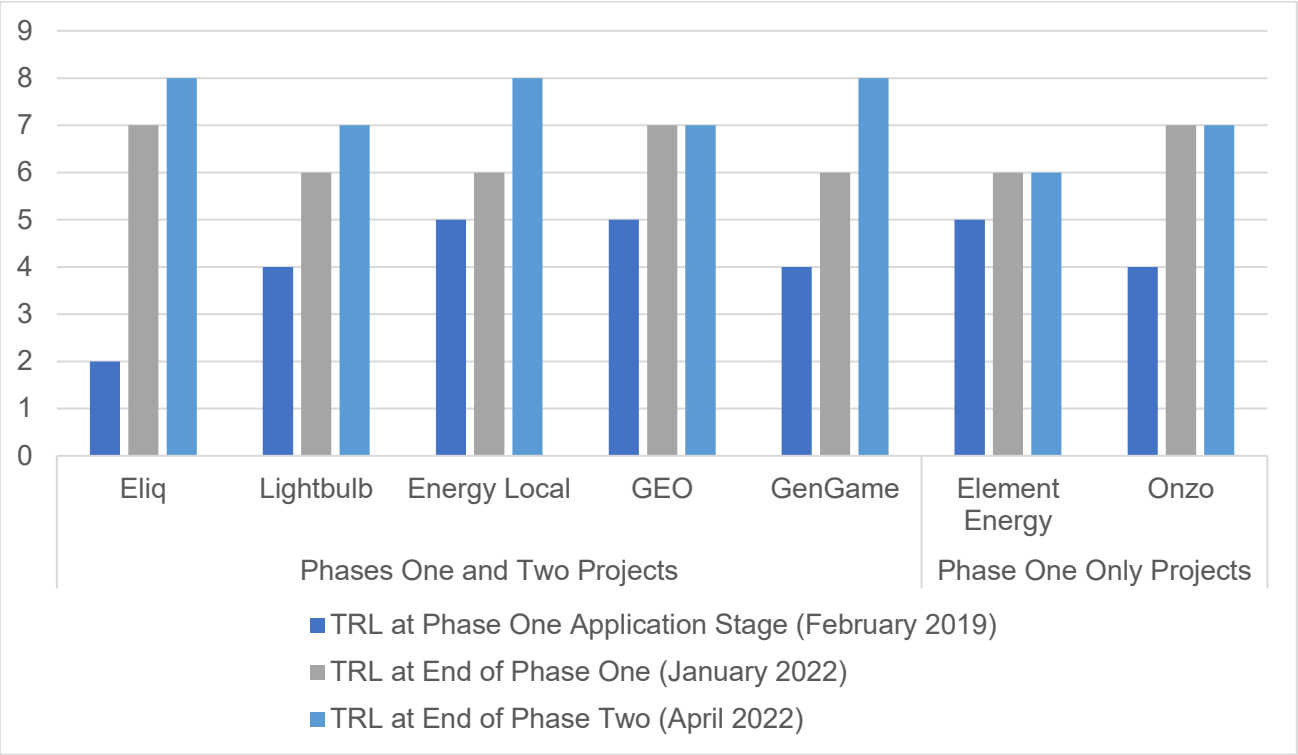
5.2.1 Progress in product development

The starting maturity of products/ services funded through SENS, assessed via Technology Readiness Levels (TRLs, See Annex 3) varied between projects (see Figure 4 overleaf[32]). Most had previously undertaken some form of basic analytical proof work and had tested software components, including advanced algorithms in controlled environments, as well as integrated various components to establish they worked together. Only one project commenced their product development work at the pre-proof-of-concept[33] stage, though had planned to integrate this into a previously functioning application system that was already operating in a commercial environment.

By the end of Phase One, most funded projects had been able to develop working prototypes of their respective product ideas, including: building and testing Application Programming Interfaces[34] (APIs) that would allow access to trialist energy consumption data, integration of datasets that could be used to provide energy efficient product recommendations, and algorithm outputs to generate personalised customer-facing advice and materials. Those developing hardware solutions had manufactured working prototypes that were proven to integrate successfully with the software components necessary to provide the core functionality to users. Some projects however, experienced technical issues with their innovation that meant Phase Two trials were not able to test the full concept of the product/ service originally specified at the point of application.

[32] Note TRL levels were assessed and self-reported by Competition Partners.
[33] Prototypes that demonstrated the design concepts in principle, were feasible.
[34] An application programming interface is a way for two or more computer programs to communicate with each other.

Figure 4: Technology Readiness Level of SENS products/ services at the start of the Competition, end of Phase One and end of Phase Two



Source: TDEL analysis of project application forms and interviews with CPs at the end of Phase One and Phase Two. Note that the Switchee project *was* excluded due to being unable for contact during the interview phase.

Prior to the start of Phase Two, five of the projects undertook small-scale pilots of their SENS products services (less than 100 households) to test the functionality and gain insights into the customer experience.

During the qualitative interviews conducted with CPs at the end of the Competition, there was a strong sense that the SENS Competition funding had helped to accelerate the development of their various products and services compared to a Business as Usual (BAU) scenario.

Competition Partners reported that Phase One of the SENS Competition enabled them to:

- Dedicate additional resource to refine and improve the quality of products, which were at an early development stage at the beginning of the Competition, and thus were perceived as riskier and more innovative than their normal offer.
- Increase the speed with which product development occurred (CPs reported that products were developed on average 12-18 months quicker within the Competition than within a BAU scenario).
- Support collaborations with academic institutions, other companies who had complementary expertise and with potential “lead buyers” (including energy suppliers).
- Hire new staff members with specific specialisations, to help with the development of specific aspects of the products (such as behavioural science and experimental

algorithms). This new expertise was also expected to help with other products in the CPs' portfolios.

- Engage with smart meter data at an early stage in the SMETS2 roll-out, in order to better understand how the data worked and test its potential functionalities with the product.

While all of the eight Phase One SENS projects had developed their SENS product/ service sufficiently to trial the innovation at scale across homes in Great Britain, two of these projects were unable to progress to Phase Two matched grant-funding as they could not demonstrate a viable approach to recruit trialists (for example, by not having secured an energy supplier as a formal partner). One other project was not able to proceed to Phase Two due to exceptional circumstances.

Three (IDEAS, Energy Local and SENS GenGame) of the five projects that progressed to Phase Two to trial their product, were able to progress their product further, reaching relatively high levels of technical maturity (TRL 8).

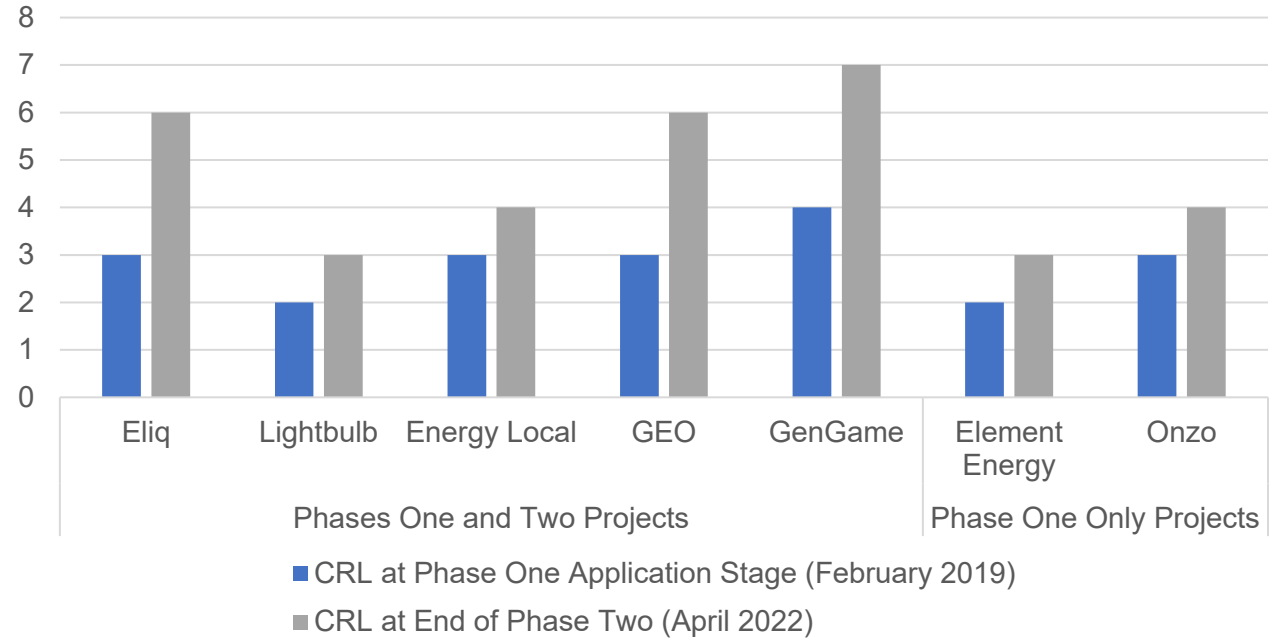
5.2.2 Progress in the commercialisation of the products / services funded

All funded projects had established the potential use-cases for their technology at the application stage and demonstrated some cursory knowledge of existing competing technologies in the market (see application stage Commercial Readiness Levels (CRL[35]) in Figure 5; see Annex 4 for a description of the CRL scale used to assess projects). Some projects had even begun to undertake small-scale testing of proof-of-concept prototypes of some of the component features of their SENS-funded innovation in homes prior to the Competition. This allowed them to refine their product development requirements during Phase One. Some examples include SENS GenGame's testing of its behavioural demand side response offering across households in the North-East of England, and IDEAS' user-feedback testing on its existing 'Be Connected' mobile application that formed the focus of its SENS technology.

Since the start of the Competition, some projects have made significant progress against their own commercial objectives and moved towards commercial validation. The remaining have made little to modest gains in commercialising their funded product / service so far (see Figure 5).

[35] Note CRL levels were assessed by TDEL.

Figure 5: Funded CPs Commercial Readiness Levels



Source: Interviews with CPs and review of project documentation. Note that Switchee is not included as did not partake in Phase One or Phase Two evaluation *data collection* activities. Note that Phase One only projects had CRL assessments *by TDEL* at the end of Phase Two despite not participating in the Phase Two of the Competition. This is because projects were assessed on progress made outside of the Competition. See Annex 4 for a description of each of the CRL levels.

In addition, Competition Partners reported that Phase Two of the Competition enabled them to:

- Undertake product trials at a larger and more rigorous scale than would have taken place within a BAU scenario. Projects acknowledged some additional small-scale testing might have been carried out, but the resource required to undertake trials of a similar nature to SENS would likely not have been available.
- Linked to the above, supporting CPs to deliver trials at scale allowed CPs to realise some of the challenges of scaling up their product/ service. The new learnings generated meant further product refinements ad taken place that could support wider rollout of the product at scale (see 'Further technology development' commercial outcome below).
- Continue working in partnership with key partners, thus strengthening partnerships and ensuring momentum was continued.
- Where further technology development was required during Phase Two, SENS funding allowed them to commit resource to resolve issues that might have otherwise required them to remove this component of the feature altogether within a BAU scenario.

This led to the following commercial outcomes:

- **Further technology development:** The experience gained in the SEN-ST project about requirements to be able to scale up deployments (i.e. the need for a simpler installation approach suitable for smart meter installers, better usability for "non-engaged" end users and further hardware cost optimisation) has been instrumental in

getting the product design right for commercialising the successor product to the SEN-ST product trialled during SENS. Another CP has opened discussions with new hardware manufacturers to explore options to bring down the price-point of a component feature of their intervention to make their intervention more accessible for users.

- **Wider rollout:** At the time of interview (towards end of SENS Competition, February to March 2022) wider rollout plans of their product/ service as reported by CPs (from four of the five Phase Two projects) included:
    - SENS GenGame energy-saver app was expected to be rolled out to Shell Energy customers for a 12-month trial period to approximately 10,000 households in 2022[36]. Further commercialisation plans were in the pipeline, including the launch, under their new consumer facing brand, of an iteration of the SENS product to be sold direct to consumers.[37]
    - Since the start of the Competition, one CP (Eliq Ltd) had sold their SENS product / service as part of a pilot project in Europe. While the original objectives of the Competition were to support the development of a domestic GB market for energy management products and services, there was appetite from one CP to explore international opportunities. The strategic decision to sell in international markets was likely due to the CP's headquarters location, being outside of the UK.
    - GEO Ltd. had secured multiple contracts with UK energy retailers for the product trialled through the SENS Competition to deploy their product at a small-scale.
    - Energy Local guaranteed that the 'live' clubs, opened during the Competition, would remain live until at least March 2023. A further two projects were under development with a different supplier that had signed a Purchasing Power Agreements (PPA), though installation of the meters and recruitment of demand customers was yet to progress.
- **CP acquisitions:** Two Competition-funded CPs were acquired during the lifetime of the Competition. Competition-funding enabled SENS GenGame to accelerate the development and trialling of their energy insights and behavioural response offering to a point where it has demonstrated clear commercial validity. In November 2021, Chameleon Technology (UK) Ltd, a smart energy technology CP acquired GenGame Ltd, enabling Chameleon Technology to deliver on its plan to provide consumers with a platform for intelligent and optimised control of their energy at home using real-time energy data insights[38]. In September 2021, Competition-funded CP, Geo acquired another Competition-funded CP, ONZO[39]. Geo intended to use ONZO's energy disaggregation technology to enhance its Whole Home Optimisation capability. While the core technology driving the acquisition was not one initially developed during the

[36] Although intended, this did not take place.
[37] https://ivie.co.uk/
[38] https://chameleontechnology.co.uk/2021/11/17/chameleon-technology-announces-the-acquisition-of-GenGame-ltd/
[39] https://geotogether.com/geo-acquires-onzo/

Competition, it nonetheless indicates appetite from market actors for services that provide machine learning capabilities that exploit large amounts of smart meter data to deliver benefits for households. Anecdotally, early market appetite for these types of analytics services developed through the Competition has come from hardware manufacturers.

- **Active marketing:** Several CPs were actively speaking with existing and new clients (primarily suppliers) about their SENS funded products and services. Some CPs had gone as far as to incorporate information about the product in their core sales and marketing materials to consumers.
- **Attracted inward investment:** Four of the eight funded lead project partners and one collaborator project partner have attracted additional private growth capital investments since the launch of the Competition, although there was no evidence to suggest that the funds raised have been used to further progress the SENS related product and therefore cannot be classed as an impact that can be attributed to the Competition. It may be possible however, that participation in the Competition has contributed towards making these CPs more attractive as investment opportunities.

Two of the Phase Two funded CPs had been unable to make meaningful progress towards commercial maturity since the launch of the Competition. The reasons for this included:

- **Acquisition or supplier of last resort changes in the energy supplier market:** A significant number of retail energy suppliers entered administration in late 2021[40], requiring them to undergo the SoLR process, where Ofgem appointed suppliers to take on customers of the failed suppliers. Suppliers that went through this process were subsequently unable to access their customers' energy consumption data, due to the SoLR process that repeals consent previously provided by customers to access this data. Inability to access energy consumption data to deliver the SENS products meant two CPs was unable to deliver their intervention as planned.
- **Set up issues:** One project was initially unable to issue bills based on smart meter and local generation data. This was later rectified through further technical development.
- **Lack of available capital to trial the product / service:** One Phase One funded CP had not taken their SENS product / service forward due to the financial resources needed to trial the product at scale and make improvements to the "beta" version of the product before it can be rolled out more widely to customers. Receiving grant funding through the Competition was a core motivation for applying for SENS funding for this CP.

[40] https://www.icaew.com/insights/viewpoints-on-the-news/2022/aug-2022/energy-supplier-collapses-highlight-bigger-sector-crisis

5.2.3 Future plans for wider rollout of their product / service

In addition to the steps already taken (outlined above), SENS funded CPs also demonstrated an appetite to explore further routes to market and were actively exploring future plans for wider rollout of their product / service. Some of these routes included:

- **Marketing the product / service to energy suppliers as a feature to upsell:** As reported by CPs, due to falling margins on a unit of energy (kWh), suppliers across the retail energy market were exploring new ways to generate revenue, including selling energy insight services such as those trialled during the Competition. Several funded CPs identified an opportunity to sell their product/ service to energy suppliers as a way to help them expand their revenue streams. Funded CPs also saw their product as a useful service that suppliers could provide to their customers for low- or no-cost to help reduce customer churn. As a result, several CPs were looking to sell their products directly to suppliers.
- **Sell direct to consumers:** CPs also viewed commercial opportunities through Direct-to-Consumer selling. CPs were considering unbundling their packaged interventions and selling services directly to customers. This route to market would enable CPs to work independently of energy suppliers, however, in this case it would be necessary to use DCC Other Users route to verify the correct smart meter associated with the property/ customer, so that smart meter data can be utilised.
- **Expanding into international markets:** All CPs were primarily focused on selling their product / service in domestic (UK) markets initially, though there was interest to expand into Western Europe and the US.

5.2.4 Barriers to commercialisation and wider adoption of the funded products / services

Linked to the routes to market outlined above, CPs reported the following barriers and challenges to further commercialisation of their product / service:

- **Limited user feedback:** All of the CPs were able to recruit trialists into their trial, some of whom then participated in research activities that gathered feedback on the products / services. Trials did not fully achieve the number of recruited customers as initially planned, with some projects significantly under-recruiting. Consequently, some trials did not have sufficient sample size/ statistical power to detect the anticipated effect sizes of their product/ service. This limited their ability to learn about potential product improvements.
- **Technical issues experienced setting up or delivering the intervention:** A minority of trialists interviewed in one of the Phase Two projects believed they experienced technical difficulties with the product / service in their home which hindered their likelihood of wider recommendation to friends and family. Approximately half of these case were due to factors unrelated to smart meters e.g. poor or intermittent Wi-Fi

connections. For the other half issues were related to smart meters (or their installation) and included:

  - Meter configuration issues – meters not correctly configured by the energy supplier
  - Meter and IHD communication issues – meters and IHDs experiencing a poor connect to the HAN

- The impact of these smart meter issues was that in some cases the GEO IHD (part of the thermostat packaged intervention) could not connect to the smart meters, dropped its connection intermittently or could not get data from the meter. For some households, this removed access to the budget functionality of the smart thermostat packaged intervention.
- **Identifying suppliers to partner with:** CPs found some supplier organisations did not have processes in place to feed smart meter data into their IT systems. This reduced the pool of suppliers that CPs could potentially partner with to rollout the products / services beyond the lifetime of the Competition.
- **Acquisition or supplier of last resort changes in the energy supplier market:** The current energy retail market situation in the UK has shrunk the number of suppliers[41] that Competition-funded CPs could sell their product / service to. There were potentially mixed effects of this:
  - The current market situation meant that switching might not be an option for consumers, leading to lower incentives for energy suppliers to offer energy efficiency solutions.
  - Tied to the recent price increases in energy that led to this market shrinkage, some CPs believed there were positive commercial opportunities associated with increased household costs of energy. The payback period associated with physical assets funded through the Competition was assumed to be shorter due to increased household energy costs and associated savings from use of the assets.
- **Smart Meter roll-out progress:** Installation of smart meters were curtailed at points during 2020 and 2021 as suppliers complied with COVID-19 restrictions. While installations have subsequently increased (and 55% of households now (as of December 2022) have a smart meter[42]), the pool of households that could utilise the products / services trialled through the Competition was lower than it would have been otherwise.
- **Incorrect/ missing tariff data on smart meters:** One CP providing half-hourly cost estimates to trialists, reported issues with tariff data stored on the meter being inaccurate or missing (this information is not used for billing, and therefore may not be updated by the supplier) - resulting in cases where the tariff on the meter did not match

[41] Bill, E., Hill, K., and Atzori, D., 2021. Consolidation in the domestic energy market. Available at: https://www.cornwall-insight.com/wp-content/uploads/2021/09/Consolidation-in-the-domestic-energy-market.pdf
[42] https://www.gov.uk/government/collections/smart-meters-statistics

the actual tariff for trialists (e.g. as shown on the trialists' energy supplier account/ bills). As a workaround to enable SENS project to rapidly progress, the CP developed an approach to obtain accurate tariff data directly from energy supplier using manual csv tariff transfer for triallists. While this did not affect any of the trialists during the trial period, the CP highlighted that future rollout of these types of products that work independently of the energy supplier would require technical enablers of DCC tariff data quality to be improved[43].

[43] It is worth noting that BEIS recently consulted on making energy supplier tariff information available in a common consistent format (https://www.gov.uk/government/consultations/delivering-a-smart-and-secure-electricity-system-the-interoperability-and-cyber-security-of-energy-smart-appliances-and-remote-load-control)

Chapter 6 The Competition's contribution to wider market impacts

This chapter summarises learnings about the Competition's intended longer-term outcomes, i.e. factors that may affect the development of a market for products and services that use smart meter data and how this has changed over time.

Developed at the outset of the Competition (early 2019), the Theory of Change (Annex 1 Figure 6) sets out the causal pathways through which the Competition outcomes were expected to be achieved. It presented the anticipated longer-term impacts of the Competition, describing what a transformed domestic energy market could look like and evolve, if the market for products that utilise smart meter data was to grow at scale. This included greater competition between energy suppliers on energy management products and services that facilitate consumer energy savings. This in turn was expected to lead to an established and innovative market for energy saving products in the domestic sector. The vision was also dependent on other factors that influence the development of a sustainable market, including real-world demonstration of the products funded through the Competition. An assessment of the 'state of the market' at the start of the Competition and the extent to which the factors/ assumptions driving change have held true during the SENS Competition, have been explored in the sections below.

6.1 Key findings

The market for products and services was relatively nascent at the start of the Competition and there was mixed evidence as to their added-value above and beyond standard IHDs: In 2018, there were only three comparable products available to domestic consumers, two of which were using smart meter data. Two suppliers had tested smartphone apps that provided near real-time consumption data, feedback, notifications, and past consumption history; while these trials did not find the app-based advice products to be good substitutes for IHDs, there was evidence to suggest these two technologies may complement one another well. More systematic research undertaken since has shown that feedback through mobile phones, computers and tablets can help improve energy efficiency and conservation.

There is evidence that several of the factors thought to support development of the market for these types of products have partially been supported by SENS: SENS funding has supported the development of products that provided both relevant and engaging information that has led to several outcomes for households, such as product satisfaction, improved knowledge and behaviour changes. This ultimately led to most trialists becoming advocates for the products, including those that did not feel they had directly benefited from using the product. While it was too early to say whether this has

led to any structural changes in the market, findings such as these support the ambition of the Competition to develop the wider market for these types of products.

There are some factors assumed to drive longer-term development of the market that would require further development from product developers and support from policymakers to facilitate further growth in the market: There are consumer demographics considered less likely to engage with the products funded through the Competition (digitally excluded and environmentally unaware groups in particular)[44] that will require further engagement from companies, policymakers, outreach groups, etc. to persuade take-up of these types of products in the future.

6.2 Scope of the analysis

The analysis presented in the remainder of this chapter considers the current state of the market for products and services that use smart meter data in domestic properties, specifically energy advice apps and smart heating controls. Through a desk review of previous trial studies for these types of products, an assessment has been made as to whether the products on offer to consumers prior to the Competition were contributing to the factors assumed to support longer-term market development. To derive an assessment of how the Competition has (or is on track) to contribute to these factors, a synthesis of the evidence presented in earlier chapters and from the trial level reports had been conducted.

A robust assessment of the market for products and services using smart meter data in the domestic sector was not possible due to the relatively nascent nature of the sector and the lack of publicly available information on take-up of products / services. Where possible, numeric figures have been used to provide further insight.

6.3 Development of the market

A desk review of the products and services trialled prior to the Competition suggested that exploratory work had begun to test the various functions of energy saving advice products, and a small number of products had entered the market. Overall, only three relevant products were available in the market by 2018, with two of these requiring smart meters. There were varying degrees of success of these products demonstrating benefits for consumers.

By Summer 2022, there were a total of 16 relevant products in the GB market, with many using smart meter data in conjunction with other devices such as IHDs or smart thermostats. An overview is provided in Table 6 in Annex 5.

At the start of the Competition, there was a varying degree of evidence on the benefits of relevant products and services. Two suppliers had tested smartphone apps that provided near

[44] Smart Energy GB, 2021, Available at: https://www.smartenergygb.org/media/z3bbrwqg/the-future-smart-energy-consumer.pdf

real-time consumption data, feedback, notifications, and past consumption history. The conclusions from BIT (2019) were that although a degree of statistical uncertainty remained around the results of the energy consumption analysis, a universal offer of an app was likely to be less effective than a universal offer of an IHD at reducing customers' energy consumption. Compared to the apps, it was also noted that IHDs appeared to be more readily adopted and better suited to a wider demographic. Ultimately, these trials did not provide confidence that alternatives to IHDs would have similar or better impacts in terms of supporting consumers reduce their energy consumption. The trials did, however, highlight a role for [app/ potential IHD] features – push messages or alerts on consumption – which may be beneficial and complementary to existing IHD features in engaging consumers. Amid the launch of SENS, some technology companies were deploying IHDs with additional functionality that allowed them to stream smart meter data to the cloud, allowing for additional analytics and services[45].

However, the evidence base grew over the lifetime of the Competition, suggesting that in conjunction with the insights produced by the Competition, there is now a substantial body of insights to draw on when developing innovative products. For instance, a systematic review[46] of 27 studies undertaken up to 2021 concluded that feedback through mobile phones, computers and tablets can help improve energy efficiency and conservation. While the provision of historical feedback was included in most studies (and can be considered as a standard in energy conservation studies), real-time feedback was offered by 16 studies and only 11 of them updated this information within the timeframe of a minute.

Other research explored the role of social comparison and financial rewards on energy conversation. In one study, comparisons with similar households were found to reduce consumption by around 6%. However, social comparisons were found to have their largest impact on behaviour change on the day that information was received, decreasing over time. Notably, the study found that social comparisons had limited impact online (even with experienced consumers who are used to online billing), therefore social comparisons delivered online may have very little beneficial effects on reducing energy use[47].

[45]BIT (2019): Impacts of alternative feedback devices on customers' energy consumption: A report from the Behavioural Insights Team for the Department for Business, Energy & Industrial Strategy

[46] I.M. Chatzigeorgiou, G.T. Andreou, (2021). A systematic review on feedback research for residential energy behavior change through mobile and web interfaces. Renewable and Sustainable Energy Reviews, Volume 135.

[47] Dolan, P., & Metcalfe, R. (2015). Neighbors, knowledge, and nuggets: two natural field experiments on the role of incentives on energy conservation. *Becker Friedman Institute for Research in Economics Working Paper*, (2589269).

6.4 Assessment of the Competition's contributions to the factors assumed to shape the market for products and services that use smart meter data

An assessment of the products and services trialled through the Competition suggests that several of the factors thought to support development of the market for these types of products have partially been supported by the Competition:

- **Solutions continue to provide relevant and engaging information and achieve high levels of user satisfaction**: There was evidence that each of the products trialled during the Competition provided relevant and engaging information to most trialists. As highlighted in Chapter 3, this led to improvements in trialist's knowledge of what consumes the most energy in the home and how they can reduce their energy consumption. Chapter 4 highlights the types of features that are most popular or well-received. There was evidence of trialists reporting a lack of novelty for some of the tips and advice received. This may be to be expected given the market for these products is still in what could be considered an 'early-adopter' phase (as evidenced by the general profile of trialists, i.e. typically they enjoy trying new gadgets and have reasonable access to finances, and high levels of education). The trialist population generally reported high levels of energy awareness prior to the start of the trial, potentially explaining why they found some of the energy saving tips to be traditional or non-informative.
- **Viability and scalability of business models**: For most of the Phase Two CPs, there were plans in place to roll out their product out more widely, highlighting their commercial viability and growing acceptance in the market. Furthermore, recent acquisitions of Competition-funded CPs are evidence of investor interest and wider acceptance of products and services that use smart meter data. Some CPs reported that there was further work needed to make their product scalable. For example, developers of the SEN-ST product have outlined plans to re-build their smart thermostat so that it can be produced at scale while becoming more intuitive to use and more cost optimised. Nevertheless, the CP specifically highlighted that the need to re-design the product specifications has stemmed from being able to trial the product at the scale enabled through the Competition, potentially highlighting the Competition's contribution to supporting the market directly. While there was largely positive evidence of the viability of business models and products trialled, CPs still highlighted several barriers in the market that would restrict wider rollout of their product. These are highlighted at the end of Chapter 5.
- **Trial households become advocates**: The majority of intervention group trialists interviewed said they would recommend the product or service to friends or family members, including trialists that felt as though they did not benefit from using the product. This was quite a noteworthy finding as it suggests that trialists understood the intended benefits of the product but acknowledged that it may only work in certain

circumstances and would therefore recommend to those they believe would benefit most.

There were some factors assumed to drive longer-term development of the market that would require further development from product developers and support from policymakers to facilitate further growth in the market:

- **TOUTs are attractive to consumers**: It was envisaged at the outset of the Energy Local trial that a simplified TOUT would make it easier to understand the costs of using energy at different times. Given the very high levels of awareness of energy consumption among trialists interviewed, this assumption did not hold true in many cases. A large proportion of those consulted (via qualitative interviews and/or surveys) were able to name with ease the appliances which were using the most electricity and reported having known this prior to joining the club. Nevertheless, a large number of respondents highlighted the volatility of energy prices, particularly with regard to the increase in the energy price cap and concerns regarding future energy prices. Access to a fixed rate (for one year) TOUT via the energy supplier involved in the trial was viewed by many trialists as a significant stabilising factor in this environment. Given that Energy Local trialists were benefiting from a fixed tariff at a time of rising prices, this feature could be less salient in different market environments.
- **Ensuring products are accessible and have mass market appeal**: The products funded through the Competition were broadly accessible to the whole GB population. All of the products / services were designed such that they could be offered to all smart meter customers. No exclusion criteria were applied except for having a smart meter installed at the home, unless in the cases of MEETS and SEN-ST that were heating-based interventions and therefore excluded homes that already had heating-related products in the home, such as a Nest thermostat. There were certain sub-groups however that were considered less likely to engage with the products funded through the trial:
    - **Digitally excluded households, i.e. those without access to a digital device such as a smart phone, tablet or computer**[48]: these types of households would have been unable to use any of the products trialled through the Competition. To an extent, Energy Local started to explore inclusion of these groups as part of their cooperative model, but this was not assessed during the lifetime of the SENS Competition.
    - **Environmentally unaware**: Competition trialists were generally 'energy aware' at the start of the trial. This may have been due to the fact that nearly all trials were only targeting existing smart meter customers or those willing to have a smart meter installed (which could be taken as a proxy for individuals being more environmentally conscious or energy aware). Given the trials were marketed to a broad base of customers, it is possible that only the most energy aware / environmentally conscious individuals signed up to the trial. This could suggest

[48] Ofcom estimates 6% of UK households are digitally excluded in regard to internet access in the home. Figures are available at: https://www.ofcom.org.uk/__data/assets/pdf_file/0022/234364/digital-exclusion-review-2022.pdf

that products could produce additional benefits if targeted at different groups of households. Further evidence is needed to explore the effects of these types of products on individuals that would fall into the next group of technology adopters, i.e. the early majority.[49]

- **Increasing awareness of energy saving measures to drive increased demand**: Several key learnings have emerged from the Competition's trials that could support awareness raising initiatives/ marketing of products to potentially customers. Chapter 3 outlines various motivating factors for signing up to the trials that future technology developers and suppliers could utilise when marketing any energy saving advice products such as those funded through the Competition.

[49] As outlined in Everett Rogers' diffusion of innovations model.

Chapter 7 Conclusions

This chapter sets out the overarching conclusions emerging from the Competition level evaluation.

Evidence gathered through the SENS Competition demonstrated that products using smart meter data to provide energy feedback and advice can deliver additional energy savings for households in addition to those enabled by the baseline smart meter consumer proposition (i.e. a smart meter installation, access to near real time feedback on gas and electricity use via an IHD, and energy efficiency advice delivered at the point of installation).

Two experimental / quasi experimental trials showed statistically significant impacts on gas consumption savings. Across all trials, customer feedback showed there was strong appetite for energy consumption feedback, advice and recommendations to help secure both energy consumption and associated bill savings. Successful trials (that demonstrated energy savings) provided:

- Advice on how to heat the home based on the trialist's real costs / usage (obtained from linked smart thermostats) and offered remote control of home heating systems through a mobile app or an IHD. Through enhanced knowledge and control, trialists were able to reduce the set-point temperature of their property whilst retaining perceived thermal comfort.
- Regular, actionable tailored advice on energy saving measures via an app that led to trialists adopting more energy efficient behaviours that resulted in less heating being used. The gamification feature was also found to improve engagement.

While some projects experienced delivery challenges that prevented their full functionality being delivered or tested, in general (and across all trials) novel, actionable and tailored feedback was valued by consumers. Viewing historical energy consumption was another common and valued feature. Whilst trials may have been biased towards more engaged consumers, there was positive feedback from trialists who valued SENS products (and were disappointed where functionality could not be delivered) and would recommend them to friends or family members.

The Competition also demonstrated a range of additional benefits. One trial provided clear evidence that trialists changed their behaviour to make full use of the electricity supply from local renewable sources available to them and used electricity at more off peak times (through the TOUT) leading to lower electricity bills and increased utilisation of low carbon energy. In general (and across all trials), trialists benefited from enhanced knowledge, awareness, and control over their household energy use.

The domestic market for energy advice/ feedback products (utilising smart meter data) has been supported by SENS but continues to develop organically with growing demand. Several factors were expected to encourage wider adoption of these types of products in the future,

including growing appetite from energy suppliers (given wider retail market context), and from consumers to help realise energy and bill savings.

For most Phase Two Competition Partners, there were plans in place to roll out their product more widely, highlighting continued commercial interest in these products and growing user acceptance in the market. Continued innovation and refinement of smart meter data access, including for third parties, will help grow the market further beyond the Competition.

Glossary

ANCOVA	Analysis of Covariance
AQ	Annual Quantity (gas)
ATE	Average Treatment Effect
BAU	Business as Usual
BEAMA	British Electrotechnical and Allied Manufacturers' Association
BEIS	Department for Business, Energy and Industrial Strategy
BIT	Behavioural Insights Team
BST	British Summer Time
CA	Contribution Analysis
CAD	Consumer Access Device
CHP	Combined heat and power
CIC	Community Interest Company
CMO	Context-Mechanism-Outcome
CO2e	Carbon dioxide equivalent
COVID-19	Coronavirus Pandemic
CP	Competition Partner
CRL	Commercial Readiness Level
DCC	Data Communications Company
DESNZ	Department for Energy Security and Net Zero (formerly BEIS)
EAC	Estimated Annual (energy) Consumption
ECA	Energy Consumption Analysis
EL	Energy Local (SENS project)

ELC	(SENS) Energy Local Club
EPC	Energy Performance Certificate
GDPR	General Data Protection Regulation
GEO	Green Energy Options Ltd.
HAN	Home Area Network
HDD	Heating Degree Day
ICE	Igloo Customer Engine
IDEAS	Intelligent Digital Energy Advisory (SENS project)
IHD	In-Home Display
IMD	Index of Multiple Deprivation
ITT	Intention to Treat
KW	Kilowatts
kWh	Kilowatt-hour
M&MH	Me & My Home profile
MDE	Minimum Detectable Effect
MEETS	More Effective and Efficient Thermal comfort with Smart meter data (SENS project)
MI	Monitoring Information
MOP	Meter Operator
MPAN	Meter Point Administration Number
OLS	Ordinary Least Squares
OWL	An energy monitor that uses a current clamp attached to a meter tail to estimate consumption, sometimes used prior to receiving a smart meter (used in Energy Local Roupell Park)
PSM	Propensity Score Matching
RCT	Randomised Controlled Trial

SEC	Smart Energy Code
SECAS	Smart Energy Code Administrator and Secretariat
SENS	Smart Energy Savings Competition
SENS GenGame	SENS GenGame Energy Saver app (SENS project)
SEN-ST	Smart Energy-Smart Thermostat (SENS project)
SERL	Smart Energy Research Laboratory, based at University College London
SM	Smart Meter
SMETER	Smart Meter Enabled Thermal Energy Ratings
SMETS	Smart Metering Equipment Technical Specifications
SMETS1	Smart Metering Equipment Technical Specifications - First Generation
SMETS2	Smart Metering Equipment Technical Specifications - Second Generation
SMS	Smart Metering Services
SoLR	Supplier of Last Resort
TDEL	Trial Design and Evaluation Lead
TOT	Treatment on the Treated
TOU	Time of use
TOUT	Time of Use Tariff
TP	Trial Protocol
TRL	Technology Readiness Level
UCL	University College London
WAN	Wide Area Network

Annex 1 Competition Theory of Change

Figure 6 Theory of Change for the Competition at the outset

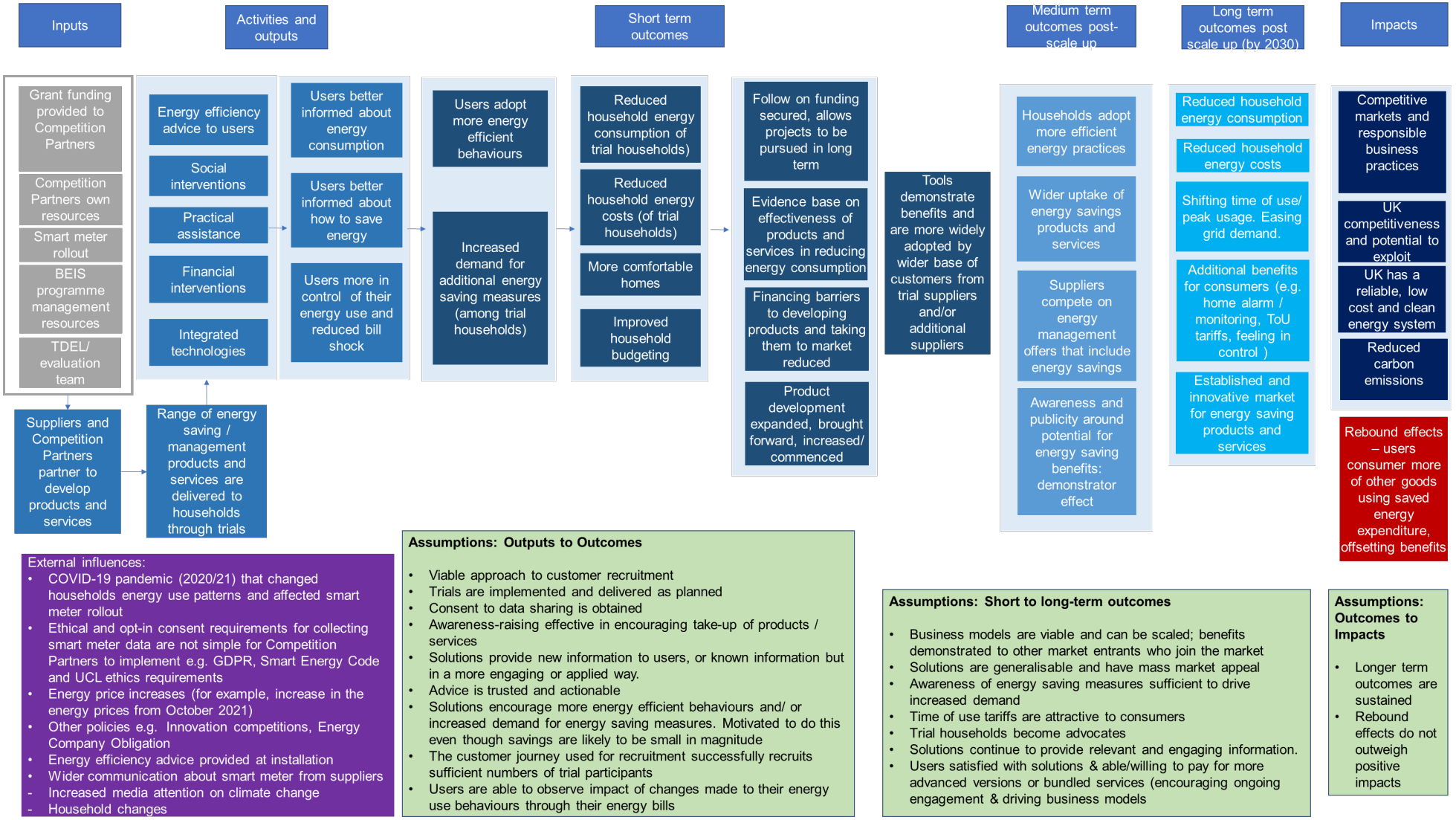
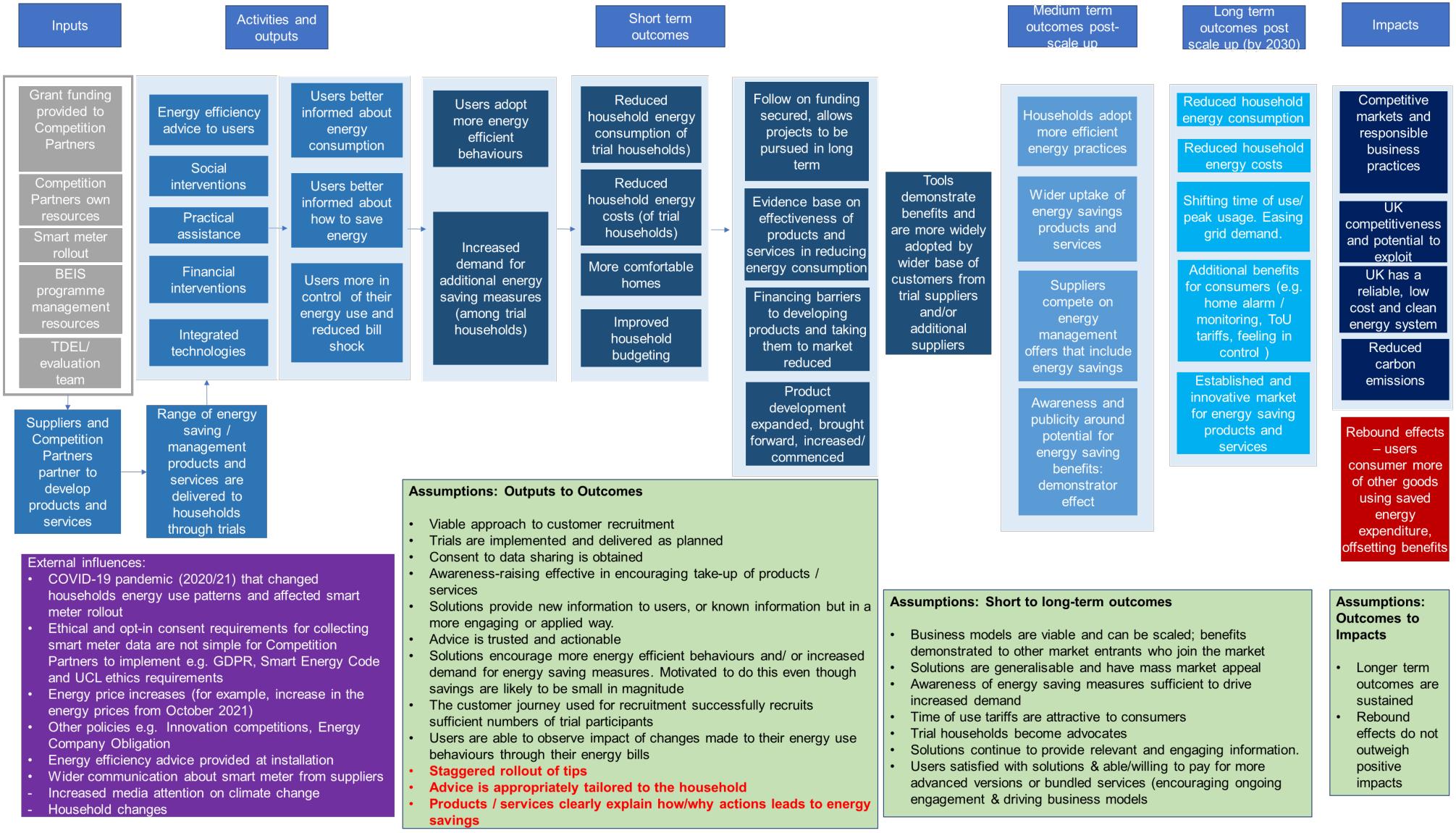


Figure 7 Revised Theory of Change for the Competition[50]



[50] Red highlighted text reflects the changes in the Theory of Change resulting from new evidence from the evaluation of the SENS Competition.

Annex 2 Overview of Phase One and Phase Two SENS projects

Table 5: Phase One and Phase Two SENS Projects[51]

Project Title	Competition delivery partner(s)		SENS smart meter innovation product
	Lead	Partner(s)	
Phase One Only- Development of SENS Products			
Providing domestic customers with tailored social comparison and smart energy savings advice in near real-time via an online tool	Element Energy Limited	Accent Marketing & Research Ltd.	Web-based application that used smart meter data to provide trialists with near real-time feedback on how their current electricity consumption compared to the historical consumption of similar households at that specific time of day and season. It also provided tailored energy saving advice and energy efficiency measures that could be applied in the household. The application provided trialists with access to videos covering guidance on how to use the product and explanations of energy concepts that informed the trialist about their energy consumption.

[51] A visual summary of the product and services funded, including their core functions and any behaviour changes associated with using the products is available here: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/950480/SENS_innovation_competition_-_Infographics.pdf

Energising Consumption Data with Alexa	SENS 2019 Limited (a subsidiary of ONZO Limited)	ONZO Limited	A voice-activated energy advice service (built into Amazon Alexa devices), that delivered energy saving advice statements to energy customers on demand (i.e. on request by the trialist). The service provided general energy saving tips, factual information about energy consumption, and targeted messages designed to encourage customers to switch behaviours from the customers' observed gas and electricity consumption usage. The intervention disaggregated smart meter energy consumption data and combined this with other data points (such as property type, age of property, number of people in household) to create an individualised customer profile that enabled delivery of a personalised service to each trialist.
Smart Energy Savings (SENS) Innovation through Switchee	Switchee Ltd	N/A	Smart thermostat designed for social housing, which combined automatic heating control with a solution that monitored the conditions of the home. Using temperature, light, motion, humidity and air pressure sensors, with gas smart meter data, the Switchee Smart Thermostat provided information to customers about heating costs and comfort levels through an In-Home Display (IHD) separate from the smart meter IHD. The Switchee solution also provided social housing associations with a landlord dashboard displaying a range of welfare and maintenance Key Performance Indicators and alerts to mould risk, poor insulation, fuel poverty risk, boiler performance and abandonment risk.

Project Title	Competition delivery partner(s)		SENS smart meter innovation product
	Lead	Partner(s)	
Phases One and Two- Development and Trialling of SENS Products			
More Effective and Efficient Thermal comfort with Smart meter data (MEETS)	Lightbulb ES Limited (parent of Igloo Energy Supply Limited)	Build Test Solutions Limited, University College London (UCL) Energy Institute	A three-part package, delivered primarily through an online web-based application, a heating report and, email and SMS notifications. The first part – 'Me and My Home' – presented to the customer an online picture of their gas and electricity consumption using smart meter data in combination with an existing data platform owned by Igloo Energy Supply Limited. Customers were then offered a temperature logger which gathered empirical data on patterns of heating within the home, resulting in a household heating report that summarised performance of the building and heating system, benchmarked against comparator homes. Finally, trialists received a package of coaching and tips on more effective heating control based on home performance and external weather temperature data, delivered via email/ text message (SMS). The three parts were underpinned by a series of components integrated to support understanding heating patterns and effective control of heating in the home.

Smart Energy-Smart Thermostat (SEN-ST)	Green Energy Options (GEO) Limited	Shell Energy Retail Limited	A smart thermostat (installed alongside and connected to a smart meter system) that provided trialists with an understanding of their whole home energy consumption, as well as control over their heating and hot water. The product consisted of three hardware devices: the display (a variant of GEO's Trio II IHD platform with various upgrades), a boiler switch (an upgraded version of GEO's Cosy boiler switch which simplified installation and reduced costs) and a temperature sensor. The SEN-ST intervention allowed trialists to view and control their heating remotely, either through the GEO IHD or GEO mobile application. By accessing household gas and electricity smart meter data, trialists with the SEN-ST technology also had access to information about their level of energy consumption in the previous week, how much they would need to spend to maintain the same level of comfort in the coming week, and what the monetary value of changing their level of comfort (e.g. by one Celsius) would be. This combination of heating controls and higher levels of energy awareness than a standard IHD can offer is one of the key benefits of the SEN-ST product and how it intends to reduce gas consumption.
SENS GenGame	GenGame Limited	Loughborough University Enterprises Limited, Lucid Energy (formerly Intelligent Data Technologies	A mobile-only application that used trialists' gas and electricity smart meter data to provide a range of energy consumption information and advice, tailored to the individual customer. The product used smart meter data to provide insights to trialists on their historical consumption patterns, as well as offer forecasted

		Limited), SO Energy (sub-contractor)	consumption. Based on the energy information collected through the smart meter, the product suggested energy saving advice measures from a built-in database that were bespoke to the customer's household. It included a gamification feature to encourage the customer to engage with it more regularly through features including league Tables, prizes, achievements and badges.
Smart Local Energy Markets with Smart Meters (SENS Energy Local)	Energy Local Community Interest Company (CIC)	Repowering London, Connected Response Limited, TMA Data Management Limited, Octopus Energy Limited	The project entailed the creation of 'SENS Energy Local Clubs'– cooperatives of households who shared access to a local small-scale renewable generator and purchased energy at an agreed price. The aim of Energy Local clubs was to increase the use of locally generated, low-carbon energy and manage overall energy consumption. There were two interventions: a core intervention, and one adapted to target potentially hard-to-reach customers. Members of the core Energy Local intervention had access to a web-based dashboard that brought together trialists' smart meter electricity data, information about the renewable energy available, and active tariffs, to show forecasts of the local renewable electricity generated and aggregate household power demand in the club. The dashboard provided tips on how to reduce energy bills and provided daily information on electricity costs at different times of the day via the TOUT forecast. This enabled members to schedule their use of home appliances at the cheapest times of day. The

			intervention targeting hard-to-reach customers provided tailored personal support and different incentives.
Intelligent Digital Energy Advisory (IDEAS)	Eliq Limited	Bristol Energy (later acquired by Together Energy Limited)	An additional artificial intelligence software feature within the existing 'Be Connected' app already developed by Eliq prior to the Competition. By using customers' gas and electricity smart meter consumption data, combined with home profile data that customers submitted in the app, Eliq created and distributed personalised energy advice for customers on how they could save energy. Customers were matched to the most relevant advice for their home and circumstances. It was intended that the advice would be personalised based on their own smart meter data and motivations (provided in response to five in-app prompts) and then delivered using the Be Connected mobile application.

Annex 3 Technology Readiness Level Index

TRL	TRL Summary
1	Basic principles have been observed and/or formulated: Lowest level of technology readiness. Scientific research begins to be translated into applied research and development (R&D). Examples might include paper studies of a technology's basic properties.
2	Developing hypothesis and experimental designs: Invention begins. Once basic principles are observed, practical applications can be invented. Applications are speculative, and there may be no proof or detailed analysis to support the assumptions. Examples are limited to analytic studies.
3	Specifying and developing an experimental Proof of Concept (PoC): Active R&D is initiated. This includes analytical studies and laboratory studies to physically validate the analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative.
4	PoC demonstrated in test site/initial evaluation of costs and efficiency produced: Basic technological components are integrated to establish that they will work together. This is relatively “low fidelity” compared with the eventual system. Examples include integration of “ad hoc” hardware in the laboratory.
5	Technology/process validated in relevant environment: Fidelity of breadboard technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so they can be tested in a simulated environment. Examples include “high-fidelity” laboratory integration of components.
6	Technology/process validated in operational environment: Representative model or prototype system, which is well beyond that of TRL 5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness. Examples include testing a prototype in a high-fidelity laboratory environment or in a simulated operational environment.
7	System complete and qualified: Prototype near or at planned operational system. Represents a major step up from TRL 6 by requiring demonstration of an actual

	system prototype in an operational environment (e.g. in an aircraft, in a vehicle, or in space).
8	Product/technology in manufacture/process being implemented: Technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of true system development. Examples include developmental test and evaluation (DT&E) of the system in its intended weapon system to determine if it meets design specifications.
9	Product/service on commercial release/process deployed: Actual application of the technology in its final form and under mission conditions, such as those encountered in operational test and evaluation (OT&E). Examples include using the system under operational mission conditions.
10	Dead end and reached.

Source: NDA (2014), Guide to Technology Readiness Levels for the NDA Estate and its Supply Chain.

Annex 4 Commercial Readiness Level Index

CRL	CRL Summary
1	Knowledge of applications, use-cases, & market constraints is limited and incidental, or has yet to be obtained at all.
2	A cursory familiarity with potential applications, markets, and existing competitive technologies/products exists.
3	A more developed understanding of potential applications, technology use-cases, market requirements/constraints, and a familiarity with competitive technologies and products allows for initial consideration of the technology as product.
4	A primary product hypothesis is identified and refined through additional technology-product-market analysis and discussions with potential customers and/or users. Potential suppliers, partners, and customers are identified and mapped in an initial value-chain analysis. Any certification or regulatory requirements for product or process are identified.
5	A deep understanding of the target application and market is achieved, and the product is defined. A comprehensive cost-performance model is created to further validate the value proposition and provide a detailed understanding of product design trade-offs. A basic financial model is built with initial projections for near- and long-term sales, costs, revenue, margins, etc.
6	Market/customer needs and how those translate to product needs are defined and documented (e.g. in market and product requirements documents). Product design optimization is carried out considering detailed market and product requirements, cost/performance trade-offs, manufacturing trade-offs, etc.
7	Product design is complete. Supply and customer agreements are in place, and all necessary certifications and/or regulatory compliance for product and production operations are accommodated. Comprehensive financial models and projections have been built and validated for early stage and late-stage production.
8	Customer qualifications are complete, and initial products are manufactured and sold.

9	Widespread deployment is achieved.

Source: Advanced Research Projects Agency–Energy (ARPA-E) Commercial Readiness Level. Available at: https://arpa-e.energy.gov/sites/default/files/ARPA-E%20T2M%20Plan%20Template%20rev.%204-30-14.docx

Annex 5 Products/ services available on the market that utilise smart meter data

Table 6: Products available on Google Play Store as of September 2022

App name/ provider	Release date/ latest available version history	No. installs (thousands)	Smart meter required/ connected	Energy behaviour advice?	Notes/ claims
Smart Meters/ Andrey Yegorov	08-Mar-15	100	No	No	Records measurements for electricity, gas, and cold and hot water
my energy live (British Gas)	23-Mar-17	50	Yes - British Gas smart energy monitor (geo)	No	Check hourly/daily energy usage
SmartThings	17 April 2017	5,000	Yes	Yes – via energy switching marketplace	Whole-home and individual device/disaggregated energy monitoring
Eliq	05-Jul-17	5	Yes, with Eliq Smart Meter Sensor	Yes	Analytics, benchmarks, forecast notifications of abnormal consumption, custom

					suggestions of how you can reduce your electricity bill
Mixergy	24-Sep-18	1	No	No	Monitors hot water tank; automated scheduling
Hildebrand Bright	1-Jul-19	5,000+	Yes – requires SMETS or E&A SMETS1 meters	No	Monitors electricity and gas usage.
E.ON Home – Solar and heating	16-Sep-19	50	No	No	
geo Home	23-Oct-19	1	Yes – requires Geo Smart thermostat or compatible Smart Meter	No	Allows you to take control of other devices in the home, such as EV chargers.
Loop Energy	24-Oct-19	10	Yes	Yes	"On average Loop users reduce their usage by 10%"; allows users to test solar power before investing; Removes need for IHD
EDF	03-Sep-20	500	No	Yes - via Energy Hub App feature	

Luna Smart Meter	02-Dec-20	1	Luna Smart Electricity Smart meters	No	Reading and management of Smart meters
My SSE	01-Feb-21	100	No	No	
My Utilita	08-Feb-21	500	No	No	
ScottishPower – YourEnergy	09-Mar-21	1000	No	Yes	Uses general term "smart home" devices
WiFi Smart Meter/ Decmetrics Ltd	14-Apr-21	10	Can be retrofitted to an Emlite single phase electronic meter	No	Displays accurate meter reads from Emlite smart meters kWh readings every 15 minutes
Hugo Energy	18-Jun-21	5	No	Yes	"Not reliant on meter telecommunication (HUGO is cloud based)"; Allows users to "find energy saving tips"
Octopus Energy Powerloop	23-Jul-21	100	No	No	Automated scheduling for EV charging
Volta for Smart Meters	30-Aug-21	100	Yes	No	

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