

energywise

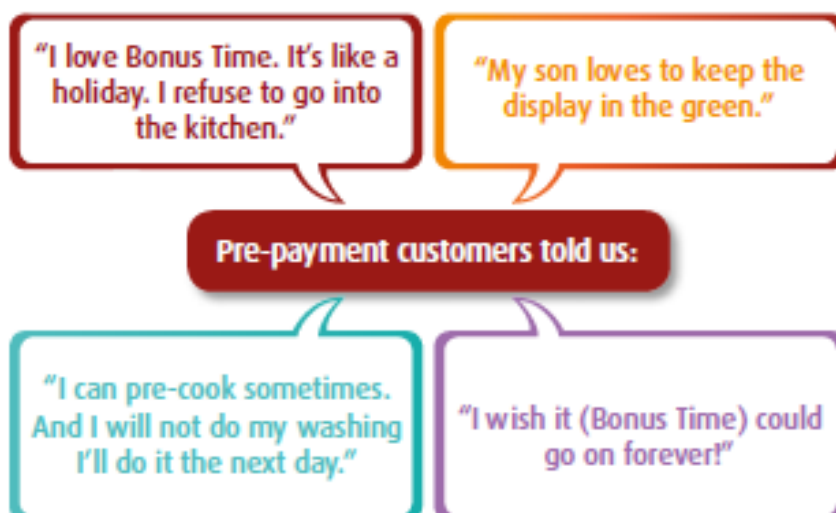
(also known as Vulnerable Customers and Energy Efficiency)

SDRC 9.5 Report

The Energy Shifting Trial Report



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Above: quotes from **energywise** participants on their experience with the energy shifting trial.

This report is the final report of Trial 2 addressing a full year of monitoring data from the **energywise** energy shifting trial. It addresses the Successful Delivery Reward Criteria 9.5 "Energy Shifting: Impact of energy shifting trial interventions – level of fuel poor participation and network impacts" set out for the Vulnerable Customers and Energy Efficiency project, also known as **energywise**, in its licence [direction](#).

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Definitions

Term	Description
Bonus Time	The Critical Peak Rebate offered to prepayment energywise participants. It provides customers with notice of 'Bonus Time' periods during which time, for every unit of electricity they reduce their consumption by (compared to their historical baseline for that time), they will be refunded the cost of ten units.
CLNR	Customer-Led Network Revolution
Control Group	The group that does not receive the interventions in Trial 1, and is used for comparison to the intervention group to see if the interventions had any effect.
Critical Peak Rebate (CPR)	Critical Peak Rebate. Suppliers, network operators and other stakeholders can call a 'critical event' during specific time periods when the supply or network is constrained. The price for electricity stays the same, but customers receive an award (rebate) if they reduce their electricity demand during the event.
Customer Field Officer (CFO)	The intermediary hired by the project to be the contact for participants, and the 'face' of the project. The Customer Field Officers duties will include recruiting and engaging participants along with gathering data.
Data logger	A non-fiscal meter that measures electricity consumption. It also referred to as secondary electricity meter.
DNO	Distribution Network Operator, responsible for managing one of the fourteen electricity distribution networks in Great Britain, delivering electricity to customers.
DSR	Demand Side Response is a change in electricity consumption in response to a signal (e.g. financial incentives)
ECG	External control group. This group of households is not part of the energywise project, their energy consumption is used as a reference for comparison.
EELG	Element Energy Load Growth (model)
Energy Social Capital (ESC)	Context-specific social capital: purposively seeking information from people known to the respondent on the topic of energy efficiency in a home.
External Control Group	A group that does not receive an intervention as part of the project, but has had a smart meter installed previously. The external control group will enable generalisations to the wider population and enable understanding of influence of external factors on energy consumption, for example fuel price changes.
HAN	Home Area Network.
HEFT	HomeEnergy FreeTime – the Trial 2 time-of-use tariff offered to credit participants, offering free electricity from 9am to 5pm on their choice of either Saturday or Sunday
HES	Home Energy Survey
ICG	Internal control group. Refers to a dataset that comprises the cleaned smart meter dataset of 144 households that were monitored during the energywise project.
IHD	In-home display. Refer to "Smart Energy Display (SED)"
Intervention Group	This is the group exposed to the treatments (interventions) in Trial 1.
LCL	Low Carbon London

Term	Description
LCNF	Low Carbon Networks Fund, administered by Ofgem. Designed to support projects sponsored by DNOs to try out new technology, operating and commercial arrangements. The aim of the projects is to help all DNOs understand how they can provide security of supply at value for money as Britain moves to a low carbon economy
LED	Light-emitting Diode
LPN	London Power Networks
MDU	Multiple Dwelling Unit meaning a building housing more than one premises with physical disparate metering such that a wireless MDU Communication Infrastructure is required.
MDU Communication Infrastructure	The wireless communication infrastructure that will be tested, installed and commissioned in certain categories of buildings.
Pilot study	A small scale preliminary study that usually takes place before full investigation in order to test certain elements of the main study e.g. a research design.
PPM	Prepayment meter
PSR	Priority service register: A free service provided by suppliers and network operators to customers in need, providing additional information and support in the event of a power cut.
Smart Energy Display (SED)	The display unit that accompanies the Smart Meter that displays the energy consumption and cost of energy unit. It is also known as In Home Display (IHD) or Smart Energy Monitor.
Smart Energy Expert	The appropriately trained engineer of British Gas tasked to install smart meters according to the Smart Meter Installation Code of Practice (SMICoP) and internal British Gas processes.
Smart Meter	The advanced meter offered by British Gas as part of their business as usual activities offering advanced functionality compared to a traditional meter.
Time of Use (ToU) tariff	An electricity tariff that varies the cost of fuel at different times of day or week, with the aim to encourage households to move electricity consumption away from peak periods.
VCEE	Vulnerable Customers and Energy Efficiency

1 Executive Summary

In December 2013, UK Power Networks was awarded £3.3 million of funding from Ofgem's Low Carbon Network Fund (LCN Fund) for the Vulnerable Customers and Energy Efficiency (VCEE) Tier 2 project also known as **energywise**. The **energywise** project investigates how DNOs, in collaboration with energy suppliers, charity groups and local community actors, can support residential customers who may be struggling with fuel bills to better manage their household energy usage and consequently their energy bills by changing their behaviour.

Help to fuel poor and vulnerable customers through schemes such as the Energy Company Obligation has historically relied on interventions with laboratory or field measured energy savings. The benefits of installing, for example, cavity wall insulation or loft insulation have been measured in laboratories and tabulated¹. In that sense, one of the purposes of the project has been to try to put energy efficiency initiatives such as **energywise** on a similar footing, so that government and other interested parties are better informed in this area.

However, to date there has been limited evidence on the benefits that can be achieved by fuel poor customers when provided with smart metering solutions, time of use (ToU) tariffs and other energy saving measures. The overarching aim of the project is therefore to monitor and measure the impact of such interventions, in order to enhance insights into the needs of fuel poor customers and to explore the means of engaging with them to facilitate increased participation in energy saving and Demand Side Response (DSR) campaigns. In this context, the project will demonstrate the extent to which this group can be engaged in such activities and, consequently, whether changes in their energy consumption away from peak demand periods can benefit the network by deferring or avoiding network reinforcement.

Following the successful recruitment campaign run in Tower Hamlets and the installation of smart meters and monitoring equipment in all participants' households, in 2015 the project commenced the first trial, which aimed to identify any change in the household energy management behaviour, and the impact on the electricity network, that can be realised through energy saving measures. The Final Energy Saving Trial report summarises learnings and findings from the first trial. The second trial commenced on 1 April 2017 and was completed on 31 March 2018. It involved giving participants a ToU electricity tariff or rebate.

At Trial 2 completion, there were 265 participants actively involved in the project, which were all social housing tenants in the London Borough of Tower Hamlets apart from one leaseholder. Out of the 265 active participants in Trial 2, 231 consented to Trial 2 tariffs. Active participants that consented to Trial 2 were split across two research groups:

- Prepayment customers (69 participants) were offered Bonus Time – a dynamic, non-punitive, Critical Peak Rebate (CPR) scheme in which customers who reduced their demand during pre-notified time periods were rewarded with additional credit on their meters. The price for electricity during these periods remained the same, but each customer was credited 10 units back for every unit of energy they saved within the Bonus Time period. Notifications were provided via SMS (plus email where desired).
- Credit customers (162 participants) were offered HomeEnergy FreeTime (HEFT) – a static, non-punitive ToU tariff. Customers could choose to receive free electricity on either Saturdays or Sundays between 09:00-17:00.

This report addresses the fifth Successful Delivery Reward Criterion (SDRC 9.5: Energy Shifting) of the project and covers a full year of monitoring data from the energy shifting trial (from April 2017 to March 2018) along with the insights regarding customer protection gathered by the project at that time.

This report is intended for:

- Policy makers and consumer groups interested in the results from the energy shifting trial.
- Policy makers, regulators, energy suppliers and DNOs looking to understand the issues around rolling out new electricity tariffs and rebates that enable time-shifting of energy demand.

¹ "Energy Company Obligation (ECO2): Measures Table", Available from:
https://www.ofgem.gov.uk/sites/default/files/docs/2015/10/eco2_measures_table_-_oct_2015-_v2_3_-_final.pdf

- Other DNOs and researchers developing or running energy saving and energy shifting trials with residential customers.

It was found that the Bonus Time offering was associated with a 1.5% reduction in average weekday evening peak demand for all households involved in this trial. The level of reduction observed from different households varied considerably, with the best performing households (top 10%) achieving average demand reductions of 18.7% during Bonus Time events (see Figure 1), which is consistent with the high levels of demand reduction achieved in other international trials of Critical Peak Rebate schemes^{2,3}. Customers earned rebates ranging from £3 to £111 per year, with the average rebate comprising £37 per year.

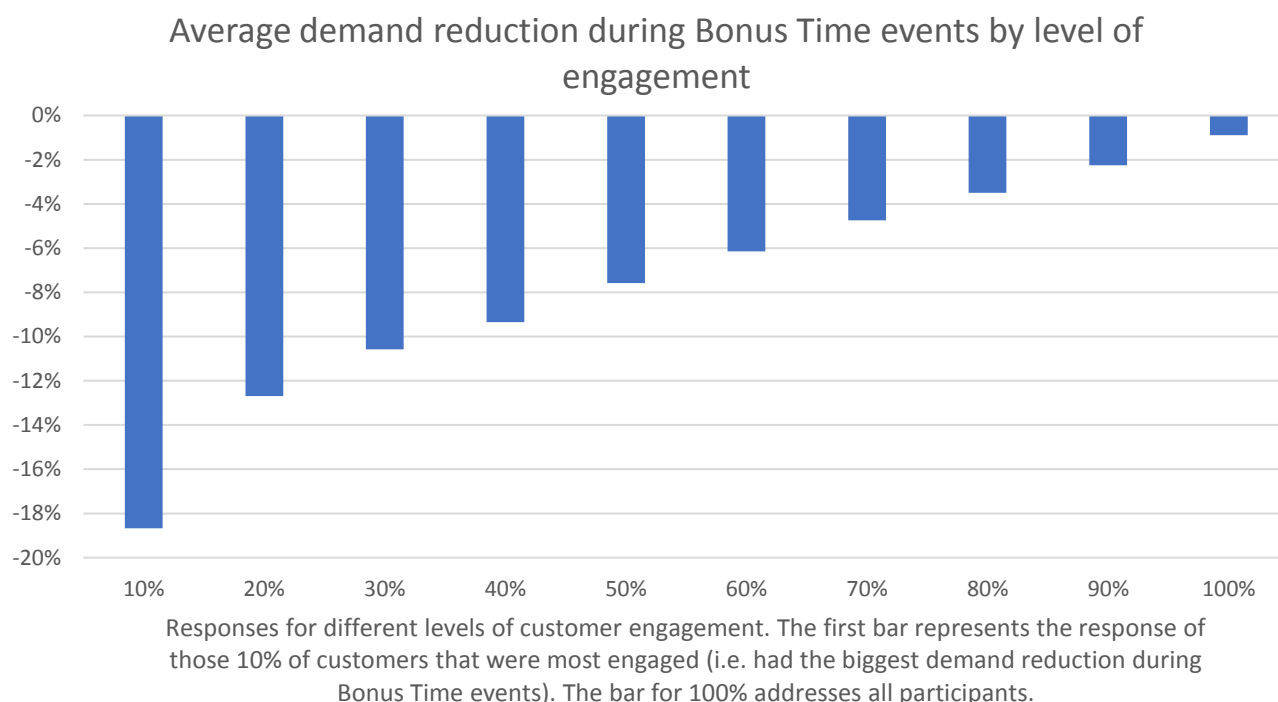


Figure 1: The average demand reduction for Bonus Time customers during Bonus Time weekday evening events by level of engagement.

HomeEnergy FreeTime participants on average shifted 0.92 kWh (equivalent to an average washing machine cycle) per week out of the paid time into the free time, saving 12p/week. The highest shifting from the paid to the free time was 8 kWh per week. The HEFT tariff was associated with an average 2.2% reduction in the weekday evening peak demand of the monitored households. However, this tariff was also associated with an average 22.2% increase in the peak demand for the weekend day containing the HEFT free period (see Figure 2). This has important implications for local network assets. At high HEFT tariff uptake levels, analysis found that many of the secondary substations involved could be subject to an increase in peak demand centred around a new substation peak during the HEFT free period. This impact was less severe for higher voltage level assets (e.g. primary substations) in which the impact is less apparent due to the contribution of industrial and commercial loads at these voltage levels.

² "BGE's Smart Energy Pricing Pilot Summer 2008 Impact Evaluation", Baltimore Gas & Electric Company, 2009.

³ "Ontario Energy Board Smart Price Pilot Final Report", IBM Global Business Services and eMeter Strategic Consulting, 2007.

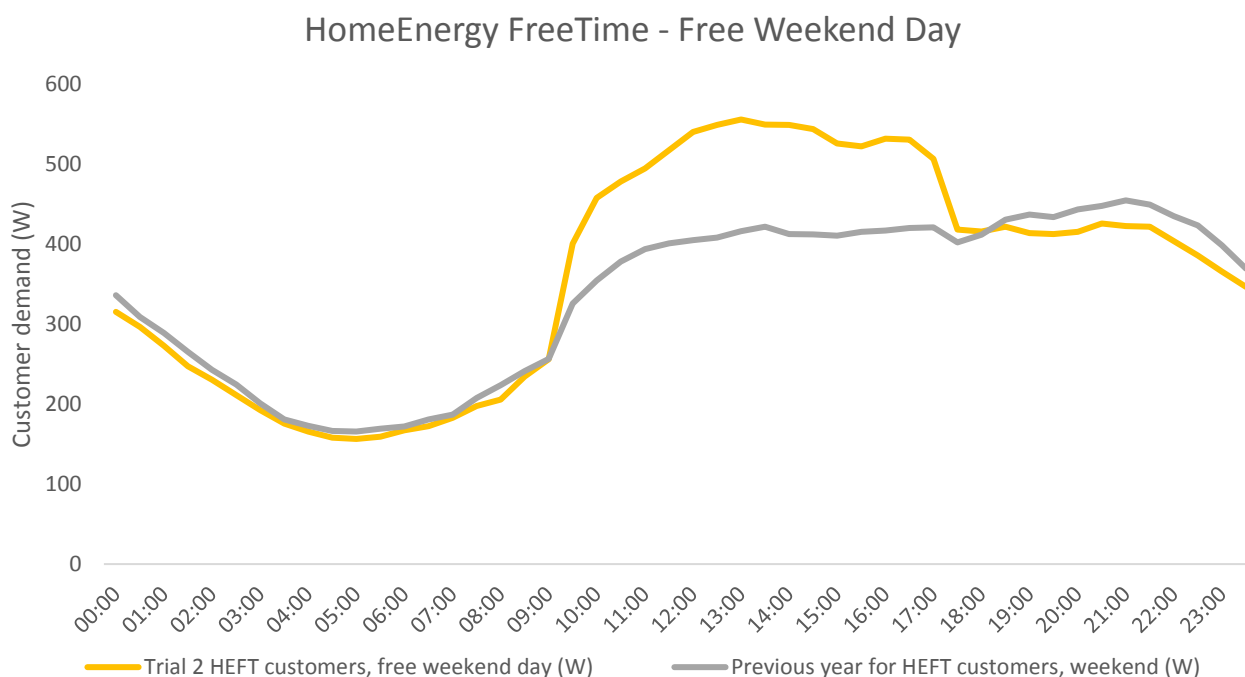


Figure 2: The average free weekend day customer demand profiles for HomeEnergy FreeTime customers during Trial 2 (yellow) versus their average weekend demand profiles from the previous year before joining the HomeEnergy FreeTime tariff (grey).

For both Bonus Time and HomeEnergy FreeTime, it was found that households possessing large flexible appliance loads (i.e. tumble dryers, electric cookers and secondary electric heating) were more able to shift their electricity demand, reflecting the importance of having sufficient flexible demand available for customer response to these kinds of demand shifting interventions. Similarly, customer engagement and understanding of the operation of these flexibility products is also important, with interview feedback indicating that the HomeEnergy FreeTime tariff was an easier flexibility product for participants to understand and respond to than the Bonus Time offering. In both cases, some participants reported that they were not able to actively engage with the schemes and in a few instances misunderstood the offer (e.g. some participants thought they were supposed to increase demand rather than reduce demand during Bonus Time events⁴).

The **energywise** project also measured participants' 'energy social capital' – i.e. the social resources they had available to help them save or shift energy. It was found that the number of people stating they had at least one person to ask about various energy saving and shifting issues increased throughout the project to 90%. Family members were most frequently identified as suitable to ask for advice. After the shifting trial, more conversations were also reported about shifting the times at which energy is used. Feedback also indicated that 95% of participants were either satisfied or very satisfied with the project (see Figure 3) and 95% of participants also feel like the project has benefited them.

⁴ It is not clear why this misunderstanding occurred since for each Bonus Time event, the customer notifications all clearly stated to "Use LESS electricity in this period to get credits" and to "REDUCE your electricity use in this period to earn credits". This messaging was also repeated in trial setup communication, newsletters and any personal contact. The Bonus Time trial is the first time a Critical Peak Rebate offering has been tested in the UK, so it may be the lack of precedence for this kind of scheme in the UK that contributed to confusion among some customers. Further clarification in this area may be required in future deployments of Critical Peak Rebate schemes in the UK to ensure full customer understanding of the fundamental scheme principles.

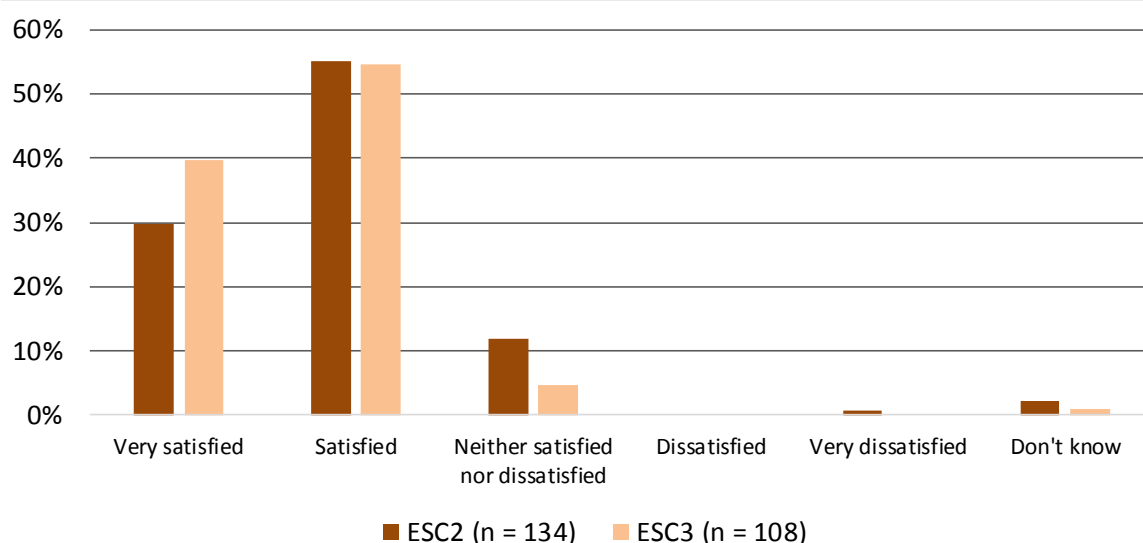


Figure 3: How satisfied are you with being part of the project so far?

In terms of broader potential, if the **energywise** Trial 1 energy savings and Trial 2 Bonus Time peak reductions⁵ were realised by all households classified as fuel poor within the UK Power Networks licence areas (see Table 1), an estimated annual reduction in electricity consumption of 86 GWh/year could be achieved in total (equating to a total saving to customers of approximately £11.2m⁶) and a network peak reduction of 27 MW (equating to a potential deferred network reinforcement cost of between £2.7m and £5.4m). While the consumption profiles of those in Tower Hamlets differ from those with some similar characteristics in other parts of GB – there is no evidence suggesting that proportionally similar energy shifting would not be observed in other DNO regions.

Table 1: Potential network impacts associated with the energywise interventions if rolled out across all fuel poor customers in the UK Power Networks licence areas.

Licence area	Number of fuel poor customers in licence area	Reduction in annual electricity consumption: Intervention devices	Reduction in network load during evening peak: Intervention devices	Reduction in network load during evening peak: Bonus Time	Reduction in network load during evening peak: Total
		GWh/year	MW	MW	MW
Eastern Power Networks	413,619	39	9.5	2.7	12.2
London Power Networks	248,684	23	5.7	1.7	7.4
South Eastern Power Networks	258,113	24	5.9	1.7	7.6
Total	920,416	86	21.1	6.1	27.2

⁵ The Bonus Time impact on peak reduction was used rather than that of HomeEnergy FreeTime due to the potential creation of new secondary substation peak loads during the free electricity periods of the HomeEnergy FreeTime tariff. Please see Section 6.3.3 for further details.

⁶ Based on 13p/kWh

The report is structured as follows:

- Section 1 is this Executive Summary of the report;
- Section 2 provides an overview of the project and its objective, the trial design and the innovative learnings that are expected to be gained through the trials;
- Section 3 describes the approach to Trial 2 recruitment, presents recruitment success rates and number of participants in Trial 2;
- Sections 4 introduces Trial 2 with an overview of the energy shifting interventions and their provision to trial participants during the Trial 2 installation phase;
- Sections 5 and 6 present the analysis of 12 months of electricity and network data from Trial 2 along with the accompanying learnings gained;
- Section 7 illustrates the technical potential associated with Trial 2 interventions and discusses this in relation to the actual savings observed for Trial 2;
- Section 8 discussed the outcomes of the customer protection measures put in place to ensure that the project follows the principle of 'do no harm' in terms of its participants;
- Section 9 summarises the key lessons captured through the set-up and operational phases of Trial 2, as well as the research study and interactions with trial participants;
- Section 10 is the Conclusion of the report; and
- Appendix A details the selection strategy for the external control group.

Table 2 illustrates where each evidence item for the Successfully Delivery Reward Criterion 9.5 for this project has been addressed in this report.

Table 2: SDRC 9.5 Evidence and report sections.

Criterion (9.5) : Energy shifting	
Evidence item	Relevant section of the report
Quantitative analysis of Trial 2 energy shifting through aggregated within-subject pre-post intervention comparison of energy use for Credit customers.	<ul style="list-style-type: none"> • Section 5 and 6 of the report provide a 12-month view of the quantitative data analysis of Trial 2 energy shifting through the comparison of the pre-trial intervention to post-trial for credit customers. The analysis is based on half-hourly data from the smart meter of each participant in Trial 2, from April 2017 to March 2018 inclusive. • Key lessons learnt are also summarised in Section 9.
Quantitative analysis of Trial 2 energy shifting for Pre-payment customers through aggregated within-subject consumption within Bonus Time period compared with a baseline constructed from previous similar days.	<ul style="list-style-type: none"> • Section 5 and 6 of the report provide a 12-month view of the quantitative data analysis of Trial 2 energy shifting through the comparison of within-trial consumption for Bonus Time period to a baseline constructed from historic customer smart meter data. The analysis is based on half-hourly data from the smart meter of each participant in Trial 2, from April 2017 to March 2018 inclusive. • Key lessons learnt are also summarised in Section 9.
Statistical generalisation of the energy shifting to the wider UK Power Networks, British Gas and national vulnerable and fuel poor customer base.	<ul style="list-style-type: none"> • Section 5 of the report outlines the strategy to assess the statistical generalisation of the findings from Trial 2.

Criterion (9.5) : Energy shifting	
Evidence item	Relevant section of the report
Representation of network impacts through half-hourly network modelling within the trial area.	<ul style="list-style-type: none"> Section 6 and 7 of the report present the half-hourly network modelling undertaken within the trial area during the 12 months of Trial 2. Under the scope of the project the Element Energy Load Growth Model was modified to address fuel poor household archetypes in the domestic sector. Half-hourly load profiles at primary and secondary substation level were compared with the energywise participants profile to identify the impact of potential savings on the network.
Comparison of realised energy shifting against previous estimates of technical potential energy shifting in the vulnerable and fuel poor customer group.	<ul style="list-style-type: none"> Section 7 of the report presents the latest technical potential estimates and compares them to the energy savings and demand shifting observed in both Trials 1 and 2. It estimates the potential energy shifting for each of the Trial 2 interventions to obtain a sense of the scale of energy shifting that could be realised in Trial 2. The identified theoretical potential estimate is compared with the realised energy shifting observed in Trial 2.
Insights on customer protection during the trial.	<ul style="list-style-type: none"> Section 8 of the report outlines the outcomes of the customer protection activities in place to ensure the project causes no harm to the trial participants. These include a regular view of the vulnerability status of trial participants, procedures to capture and escalate customer issues, customer panels and the temperature monitoring protocol. Key lessons learnt are also summarised in Section 9.

2 Introduction

2.1 The Project



Figure 4: Project brand.

The Vulnerable Customers and Energy Efficiency (VCEE) project also known as **energywise** is a partnership between nine organisations, led by UK Power Networks. Ofgem awarded the project £3.3 million of funding, under the LCNF competition scheme in December 2013.

energywise explores how residential customers who may be struggling with fuel bills can better manage their household energy usage and consequently their energy bills by changing the way they use electricity. The project undertook a research study across two trials with households who may be struggling with their energy bills in the London Borough of Tower Hamlets. The trials tested different ways of helping households better understand and control their electricity spending, enabling them to make changes which may save them money on their energy bills.

Firstly, the project explored whether households benefit from smart metering solutions (smart meter and smart energy display) and from energy efficiency technologies such as energy efficient light bulbs, an eco-kettle and a standby shutdown device.

Secondly, the project worked to understand households' appetite to change their behaviour when on a 'time-of-use (ToU)' tariff or rebate targeting electricity, with favourable rates or payments within specific time windows.

The project focused on understanding:

- The extent to which this residential customer group is able and willing to engage in energy saving campaigns and a ToU tariff or rebate;
- The benefits that they can realise from their change of behaviour in household energy management;
- The challenges and best approaches to engaging with these groups of customers to achieve these aims; and
- Whether their reduction in demand, and shifting demand away from network peak periods may benefit the electricity network by deferring or avoiding network reinforcement.

This report addresses the potential changes in household energy management behaviour, and the associated network benefits, that can be realised by customers that may struggle with their energy bills when provided with smart metering solutions, energy saving interventions and new electricity tariffs that enable time-shifting of energy demand. It also illustrates key insights into the demographics of trial participants, the way they use energy and their attitude towards energy saving technologies and ToU tariffs; as a result, the report provides a greater understanding into






- i) this customer base that will inform best practices to engaging hard-to-reach customers in the smart meter roll-out, in similar energy efficiency campaigns and in Demand Side Response (DSR) opportunities, and
- ii) the potential for shifting demand away from network peak periods.

2.2 Project partners

energywise is a partnership between nine organisations led by UK Power Networks (Table 3).

Table 3: energywise partners

Project Partner	Role in Project
	<p>UK Power Networks owns, operates and manages three of the fourteen electricity distribution networks in Great Britain, delivering electricity to over eight million customers in London, East and the South East of England. UK Power Networks own the licensed distributors London Power Networks plc, Eastern Power Networks plc and South Eastern Power Networks plc. UK Power Networks is a network operator and does not generate or buy electricity nor does it sell to end customers. UK Power Networks operates in the most challenging, fastest growing, and highest cost part of the country.</p> <p>As a DNO, UK Power Networks takes electricity at high voltages from the National Grid and transforms it down to voltages suitable for commercial and domestic use.</p>
	<p>The role of British Gas in the project is related to technical enablement and will provide the smart meters, smart energy display (SED), and ToU tariff required for the targeted customer group to engage with demand side response. British Gas installed (in cooperation with its contractors) the appropriate communication infrastructure required at households that require a communications solution for installing smart meters and smart energy displays in complex Multiple Dwelling Units (MDU) with challenging meter arrangements. Please note British Gas are providing considerable in-kind funding to the project.</p>
	<p>Since its foundation in 2009 UCL-Energy has developed a strong national and international reputation for research in energy demand and energy systems. University College London is the research authority of the project and its aim is to ensure that the results of the trials are statistically rigorous and the findings could be replicated in future.</p>
	<p>Tower Hamlets Homes is the arm's length management organisation of the London Borough of Tower Hamlets, managing the council's housing stock on its behalf. Tower Hamlets Homes has provided a list of eligible tenants, along with insights into the area and local intelligence that has shaped the customer engagement strategy.</p>

Project Partner	Role in Project
	Poplar HARCA is a registered social landlord that operates as an independent non-profit charity in the London Borough of Tower Hamlets, separate from the local authority. Poplar HARCA has provided a list of eligible tenants. They also provided insights into the area and local intelligence that has shaped the customer engagement strategy.
	Bromley by Bow community Centre is a local charity established in 1984 by Andrew and Susan Mawson and has built up considerable goodwill in the area. They are the employer of the project's Customer Field Officer (CFO) team, which is the team dedicated to the recruitment and engagement with the trial participants (prospective and actual).
	CAG Consultants is a sustainability, climate change and community engagement consultancy which is representing the voice of the customer in the project. CAG Consultants will provide specialist support, guidance, mentoring, training and evaluation of recruitment and engagement with vulnerable and fuel poor customers.
 <i>Action for Warm Homes</i>	NEA is the national fuel poverty charity which aims to eradicate fuel poverty and campaigns for greater investment in energy efficiency to help those who are poor and vulnerable. NEA provides expertise in energy efficiency and customer focus due to its continuous engagement with fuel poor customers.
	Element Energy is a strategic energy consultancy specialising in the intelligent analysis of low-carbon energy across the sectors of power generation and distribution, transport and buildings. Element Energy provide the analysis of the network impacts of the energy saving and energy shifting interventions through network modelling within the trial area.

2.3 Project overview

The project has engaged fuel poor customers who may be struggling with fuel bills to understand how they can benefit from energy efficiency measures⁷ and whether they can reduce their electricity consumption at peak times through a ToU tariff or rebate (known as 'DSR'), generating both customer and network benefits. The overall timeline of the project is presented in Figure 5. It involves two trials, as shown in Figure 6.

Upon signing up to the project, participants were randomly split into one of two groups:

- the intervention group (group 1) who received their smart meter, Smart Energy Monitor and devices at the start of Trial 1, and were then offered a time-of-use (ToU) tariff or rebate as part of Trial 2; or

⁷ In this report the term 'energy efficiency' also encompasses 'energy conservation'.

- the control group (group 2), who did not receive the interventions in Trial 1 (in order to be used for comparison to the intervention group to see if the interventions had any effect). They received their devices at the start of Trial 2.

Both groups were merged together in the second trial by which time they had all received the same interventions. Participants also had temperature monitoring equipment installed as a customer protection measure.

At Trial 2 completion, there were 265 participants actively involved in the project, which were all social housing tenants in the London Borough of Tower Hamlets apart from one leaseholder. Out of 265 active participants, 189 were credit and 76 prepayment customers and 231 consented to Trial 2 tariffs.

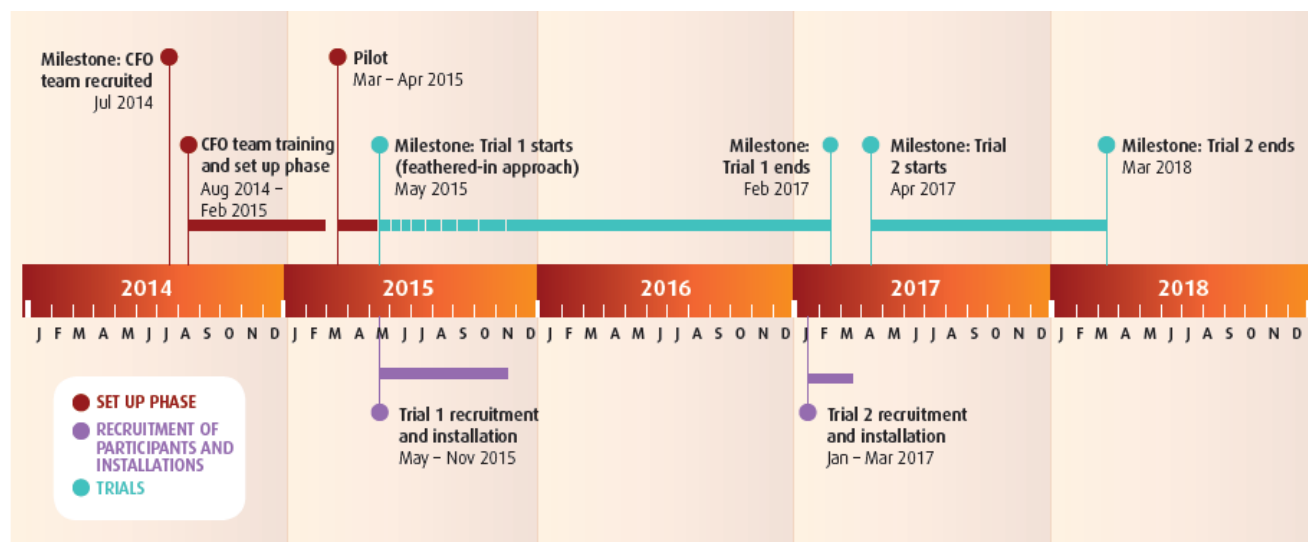


Figure 5: Overall project timeline showing the set up phase (including the project pilot), Trial 1 and Trial 2.

The project trials

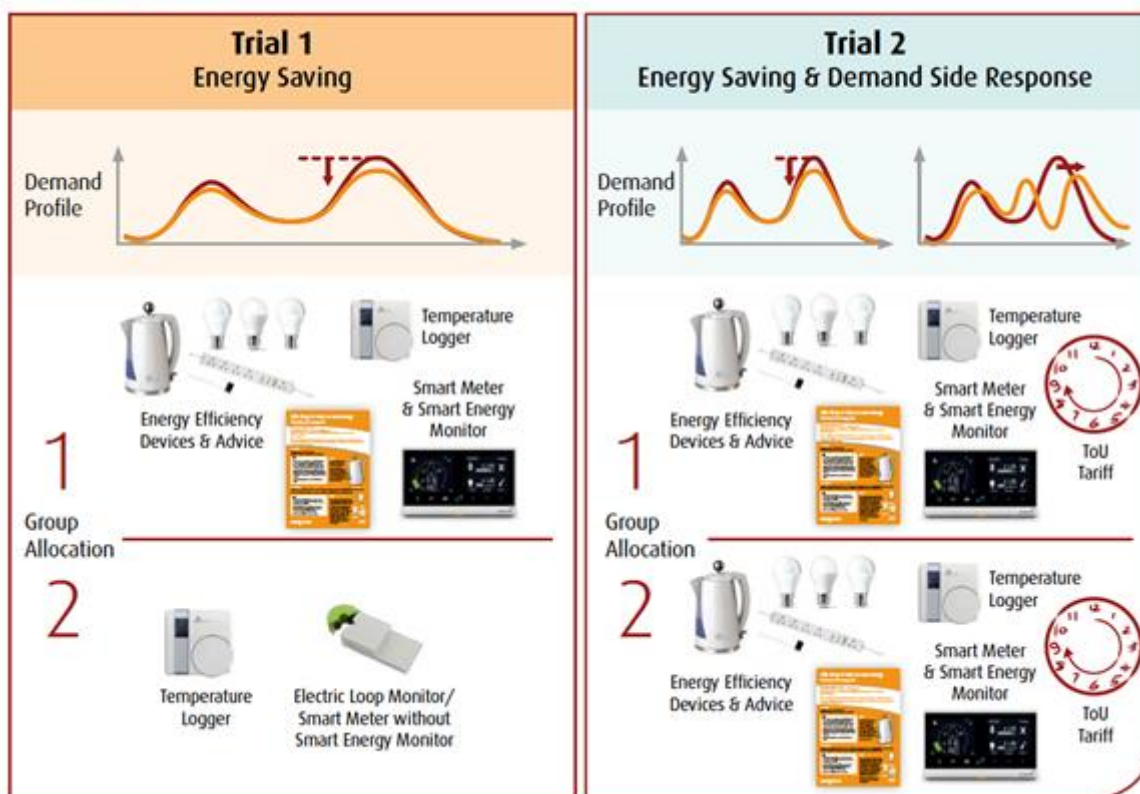


Figure 6: The project trials.

2.4 Project aims and objectives

The aim of the project is to understand how fuel poor households can benefit from smart meters, smart energy displays and energy efficiency appliances, and also how they respond to ToU electricity tariffs and rebates. The project has three specific objectives:

- **Engage fuel poor customers to understand how they can benefit from energy efficiency and participate in demand side response.** Reducing electricity consumption may result in lower bills and could thus assist in reducing the likelihood of these households being in fuel poverty or the depth of their fuel poverty.
- **Quantify the demand reduction and time-shifting that these customers could provide.** Quantification is vital if initiatives like **energywise** are to attract similar status to other proven interventions such as cavity wall insulation and low energy lightbulbs. The peak time for electricity consumption in the UK is typically between 5 and 8pm for domestic customers⁸. Limited direct research has been conducted in the electricity profile of the fuel poor domestic customer group and one of the project aims is to improve understanding of the demand profile of this domestic customer group in Trial 1 and based on this understanding develop an appropriate ToU tariff(s) for use in Trial 2.
- **Understand the challenges and best approaches to engaging with this group of customers.** It is frequently argued that fuel poor customers require additional help and support to engage with smart meters and energy efficiency devices in order to enable them to access the benefits of these. UK Power Networks found that in the LCL trials, those living in areas categorised as being 'Inner City Adversity' were the most likely to refuse a smart meter, stating that they felt it was too technical or confusing. The project is investigating how existing social networks, which fuel poor households trust, can be identified and used to effectively engage these customers in the adoption and use of smart metering technologies. It also investigates what engagement materials and communication channels are most effective in engaging with and supporting these customers.

The project will provide DNOs and suppliers with evidence-based learning on how to work with third party agencies to deliver energy efficiency and demand side response campaigns to fuel poor customers. It will also determine the extent to which fuel poor customers are willing and able to provide demand reduction and time-shifting services to alleviate network constraints and whether this is material.

The LCL project found that there are sizeable opportunities for lower income households to reduce energy use, particularly at peak times, through changes to their lighting and appliances, particularly in households of three or more people. Moreover, research carried out for DECC and Defra, using data from 250 households, estimates that fuel poor households have the technical potential to reduce their demand by an average of around 650 kWh per year⁹. Analysis of these figures suggest that a peak shift for fuel poor households of up to 200 MVA across Great Britain is technically possible¹⁰; this is the equivalent to the output from a small-to-medium sized power station. These figures were based on owner occupiers whereas **energywise** focuses on social housing tenants; this project is contributing to fill this gap in data. They are also based on assumptions about occupant behaviour rather than observations and thus are not comparable with the findings of field trials.

2.5 How is the project breaking new ground?

The project is breaking new ground in a number of areas:

- **Customer insights:** Exploring how fuel poor customers can respond to energy efficiency measures, smart meter information and price signals in order for them to reduce their energy bills. The project is also investigating what opportunities can be created for the customers through an end-to-end coordinated

⁸ Elexon 2013 'Load Profiles and their use in Electricity Settlement' https://www.elexon.co.uk/wp-content/uploads/2013/11/load_profiles_v2.0.cgi.pdf

⁹ Source: DECC, Defra and the EST (2012), Household Electricity Survey: A study of domestic electrical product usage

¹⁰ Low Carbon Networks Fund submission from UK Power Networks – Vulnerable Customers and Energy Efficiency, 28th November 2013

approach between different parties in the value chain. Also, the needs of the fuel poor will be further analysed, identified and profiled and such learning can tailor services offered.

- **Network insights:** Investigating the ability of fuel poor customers to reduce and shift their electricity consumption away from peak times and establishing whether the impact of this is significant enough to defer network reinforcement. The project will support suppliers and DNOs in realising this potential contribution in a sustained manner, thus helping DNOs to manage the increasing and uncertain demands on the network.
- **Customer recruitment & engagement:** Establishing how best to engage with fuel poor customers on energy efficiency and demand response including the most effective messages and approaches. In addition, the project is going to provide insights on the challenges faced and best practises identified when recruiting and engaging with fuel poor customers and this learning will be used in order to tailor the services offered from the DNO and other stakeholders participating in the project.
- **Innovative partnerships:** Exploring the effectiveness of DNOs and energy suppliers working with trusted local organisations who support those in fuel poverty and whether and how this can result in fuel poor customers being better served. The project lessons learnt will provide recommendations on how DNOs can work collaboratively with electricity suppliers and community actors to better identify, understand the needs, assist and deliver services to the fuel poor, within existing obligations.
- **Non-punitive time of use tariffs:** One key area of innovation in the project is trialling both credit and prepayment non-punitive time of use tariffs with fuel poor customers. Trial 2 will provide learnings on the efficacy and consumer acceptability of this class of tariff for this customer segment. Only punitive tariff structures have been trialled in LCNF projects to date (e.g. CLNR and LCL). Having quantitative and qualitative data on fuel poor customers' responses to such non-punitive tariffs is critical to the understanding and evolution of this class of tariffs in Great Britain.

As part of the project, the energy supplier British Gas is also exploring the effectiveness of working with local and trusted third parties such as the housing provider and community centre in order to carry out a locally targeted, community-led installation programme of smart meters.

Smart meter roll-out insights

The project also involves testing key parts of the smart meter infrastructure, including prepayment smart meters and the benefits they can bring to customers (such as remote top up) and how best to roll out smart meters in multiple dwelling units (which present a number of technical challenges):

- **Prepayment smart meters:** As part of **energywise**, British Gas is testing its first SMETS1¹¹ compliant smart meters with prepayment functionality, outside their trial environment (with 93 prepayment smart meters installed as part of this project). This is providing an opportunity to gain valuable early learning as to the extent prepayment customers engage with smart meters and how they use their smart energy displays to manage their consumption and their budget. Smart prepayment will also open up new, more convenient payment options to customers (e.g. over the telephone, online or via their in-home display), meaning they no longer have to worry about losing their key card.
- **Multiple Dwelling Units (MDU):** Communications between meters in basements and displays in the home – in Trial 1, British Gas has installed a communications backbone into a block of flats where the meters are contained in a communal meter room in the basement, remote from the flats in which the residents themselves live and will be using their in-home displays. Within the Smart Metering programme, these are referred to as Multi Dwelling Units (MDUs) and are a known challenge for the roll-out. This communications backbone enables the smart meter Home Area Network (HAN) services to be received by the recruited households located on different floors of the building. These households would not otherwise have been able to fully access the benefits of the smart metering solution. This provides valuable technical learning, but also gives insight into the cost of this type of infrastructure as well as the commercial arrangements required between energy supplier, landlord and customer. This is something that has not yet been fully resolved as part of the smart meter implementation programme and the

¹¹ SMETS1 are the first version of the Smart Meter Equipment Technical Specifications.

demonstration carried out in Trial 1 is resulting in the UK's first end to end installation of residential smart meter sets operating across a MDU/tall and difficult building solution, thus informing the market.

Project innovation is summarised in Figure 7.

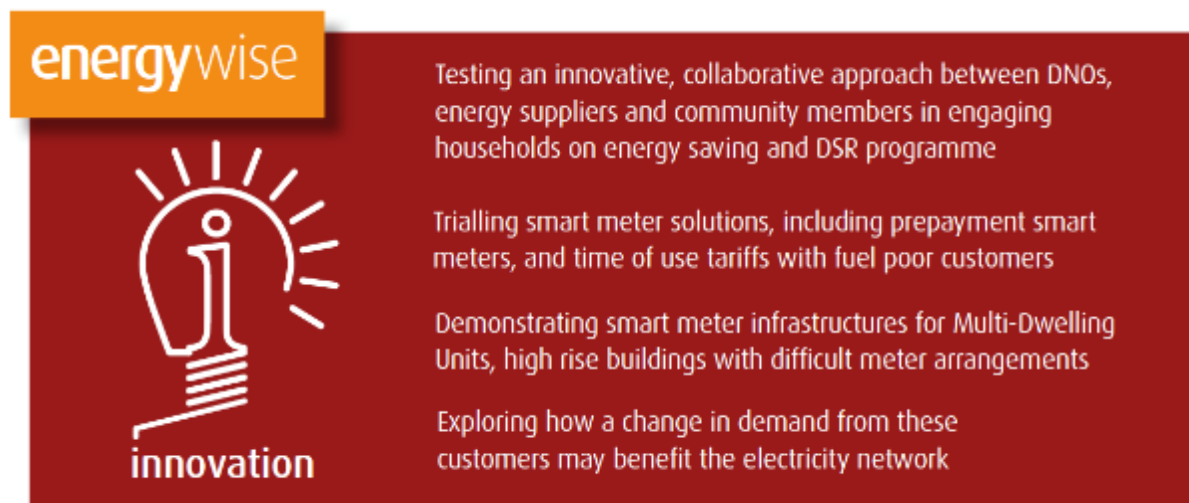


Figure 7: How energywise is innovative.

3 Trial participants

This chapter provides an introduction to the **energywise** trial participants, illustrating how they had been selected and recruited. It also presents key insights gathered through research surveys that provide a portrait of the type of households involved in the project.

In order to understand the demographic of the trial participants and to contextualise their energy consumption, two surveys were developed by University College London:

- **Home Energy Survey** (Section 3.3), which contains variables relating to ownership of many energy-consuming devices (e.g. wet and cold appliances and white goods, TVs, computing, lighting) and socio-demographic variables relating to the household (e.g. household size, ethnicity, primary language, income).
- **Energy Social Capital Survey** (Section 3.4), which investigates both individual and collective energy social capital of **energywise** households. The last survey focuses particularly on the evolution of the energy social capital over time.

3.1 Selection and recruitment of trial participants

3.1.1 Selection criteria

The project has adopted the 'Low Income High Cost' (LIHC) definition of fuel poverty, where a household is considered to be fuel poor if the residents would have fuel costs above the national median level if they were to heat their homes to the designated levels, and were they to spend that amount on fuel they would be left with a residual income below the official poverty line¹². However, the project will also assess participants' fuel poverty status in accordance with the 10% definition for comparative purposes as Government measures using this indicator.

To accurately determine whether a household is fuel poor would require information on the construction of the property, technology performance (e.g. boiler efficiency), household characteristics and fuel costs. In the absence of having all this information and due to the lack of publicly available data on households' income and fuel costs, a series of proxies have been used to identify the fuel poor.

As discussed in the SDRC 9.1 and 9.2 reports, the inclusion criteria selected by the project to target eligible households are the following:

- British Gas dual fuel customers¹³;
- Social tenants of either Poplar HARCA or Tower Hamlets Homes;
- Gas heated properties; and
- Property EPC rated G, F, E, D or C in this priority order (generally speaking, this range of EPC ratings excludes those properties that have double glazing, cavity wall insulation and loft insulation).

In addition, **energywise** defined a series of criteria for exclusion of households from the project:

- Households that have had energy efficiency improvements since October 2013;
- Households that are known to be scheduled to have energy efficiency improvements over the course of the project;
- Households scheduled for demolition over the course of the project;

¹² Department of Energy and Climate Change (DECC), "Annual Report on Fuel Poverty Statistics, 2013," London.

¹³ To maximise participant volumes the project had to relax this criterion and utilised British Gas customers who had either their electricity only, or electricity and gas supplied by British Gas. Only customers with both gas and electricity supply to their property (regardless of the gas supplier) were eligible for the project. Those customers who did not have a gas supply and resided in properties that were electricity supply only (i.e. electrical heating and/or electrically operated hot water/hot water storage) were excluded from the project.

- Leaseholders and other non-social tenants¹⁴;
- Households for which British Gas does not have annualised electricity consumption data for the year ahead of the pilot study;
- Households that were occupied by another tenant the year before Trial 1;
- Households that have Economy 7 tariff (and circuit) for electricity;
- Households that rely on communal heating, district heating or other form of heating that does not include individual gas meter;
- Households that have given notice to British Gas to switch supplier;
- Households vulnerable to power cuts, especially those who are blind, visually impaired or reliant on medical equipment. These households were excluded during the selection process if the information was available to British Gas at that time (see Section 8.1 for the review of vulnerable households post consent); and
- Households with properties in a MDU apart from those in the tower block selected to install the MDU solution trialled by the project (Padstow House).

Finally, a series of additional exclusion criteria were applied by British Gas to remove customers that could not take part to the project:

- Households who were highlighted as “seriously ill”, or “confined to bed”;
- Households with a change of tenancy in progress;
- Households that requested to be excluded/opted out of receiving marketing materials;
- Deceased customers;
- Households having a history of theft of electricity;
- Independent Gas Transporter Sites (IGTs) that develop, operate and maintain local gas transportation networks;
- Multiple meters (more than one meter per household (sub metering));
- Occupier accounts (no name on account);
- Three phase meters (mostly used in industrial and large commercial settings where powerful appliances are powered);
- U16 meters (large capacity gas meter).

Further to the identification of eligible households based on the previously mentioned criteria, the identified properties have been also categorised and selected by British Gas according to their metering arrangements in order to ensure the feasibility of each eligible household for smart meter installation.

3.1.2 Trial 2 recruitment process

Trial 2 focused on encouraging customers to shift their electricity use at certain times through energy shifting interventions such as Time of Use (ToU) tariffs and rebates. A different energy shifting intervention was offered to participants who pay for their electricity through a credit meter and those who have a prepayment meter. Trial 2 participants were recruited from existing active **energywise** participants (i.e. from Trial 1). The recruitment for Trial 2 commenced in December 2016 and was completed in March 2017. It included the following phases:

- warm up marketing comprising notification of the upcoming trials in the project newsletters issued in December 2016;
- testing of communication materials;
- recruitment by British Gas and Bromley by Bow Centre;

¹⁴ One leaseholder has been included in the project to demonstrate the MDU Communication Infrastructure, as illustrated in Section 3.1.2. The literature provides evidence that property ownership does influence occupant's decisions with respect to energy efficiency investments in the fabric of their property. These relate to issues that impact on heating of, and hot-water use in properties. There is no evidence that being a leaseholder influences occupants' behaviour with respect to those factors determining shifting of energy use, including factors such as use (or purchase) of equipment that was shown by this trial or other trials to be related to energy shifting. Shifting is not influenced by lease holding, and therefore inclusion of this participant did not influence the outcome of the trial 2 analysis.

- smart meter installation and energy saving advice for control group participants¹⁵; and
- shifting advice to all active participants just prior to Trial 2 commencing.

The full timeline is presented in Figure 8.

energywise trial 2 recruitment and installation timeline

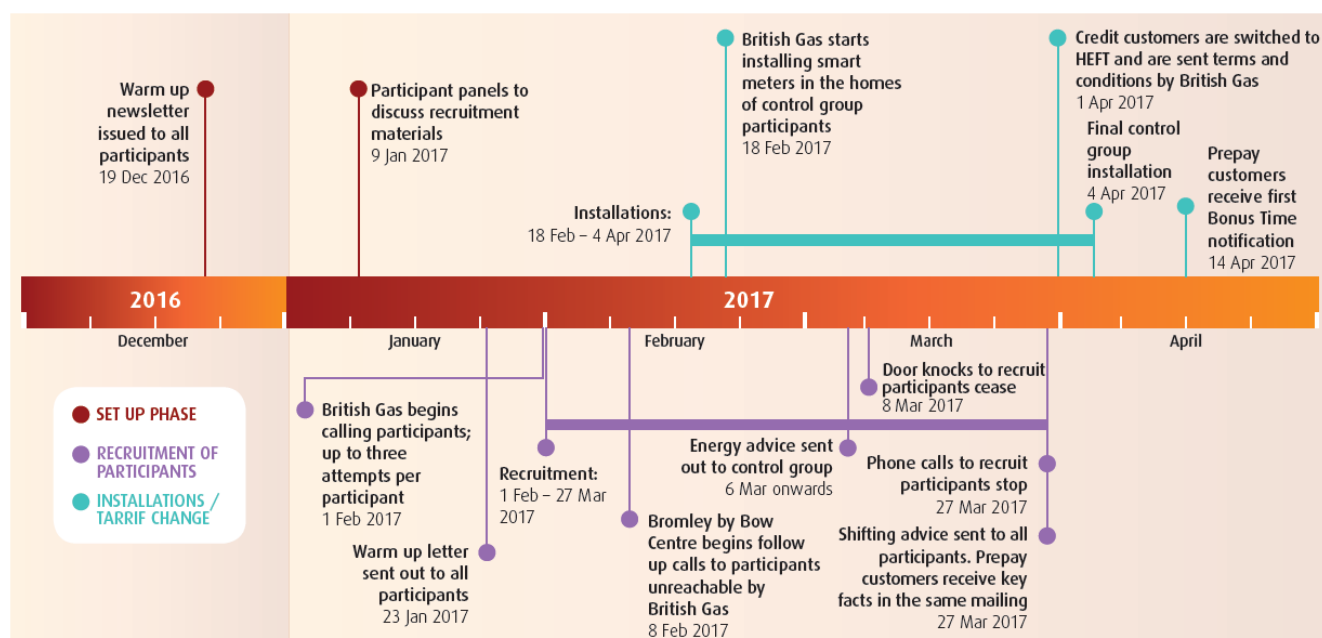


Figure 8: Trial 2 recruitment and installation timeline.

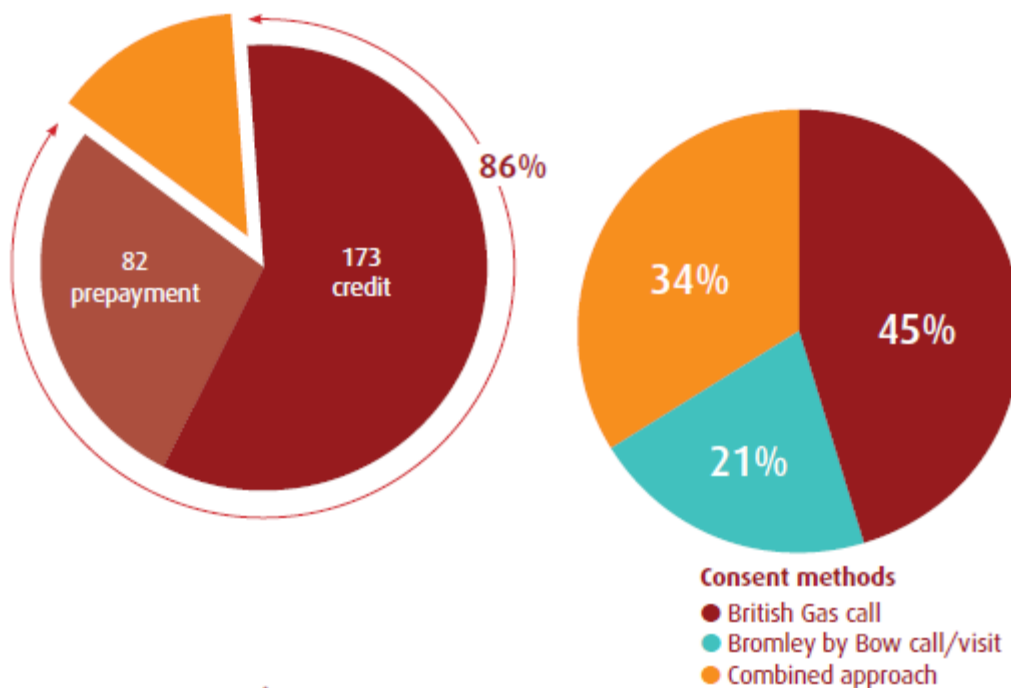
3.2 Trial 2 recruitment outcomes

As shown in Figure 9, a high proportion (86%) of participants who were active in the project at the start of Trial 2 recruitment signed up to Trial 2. Sign-up rates for the two tariffs were similar (Figure 10 and Figure 11). The recruitment approach built on learnings from the Trial 1 recruitment process in terms of the best time of day to call (after 10am and avoiding the afternoon school run).

¹⁵ The delivery of the energy efficiency devices commenced just prior to Trial 2 recruitment in order to help with control group engagement and minimise project attrition.

Trial 2 achievements

296 households approached
255 consented resulting in
86% consent rate



Interactions:
67% consented within three
77% within four

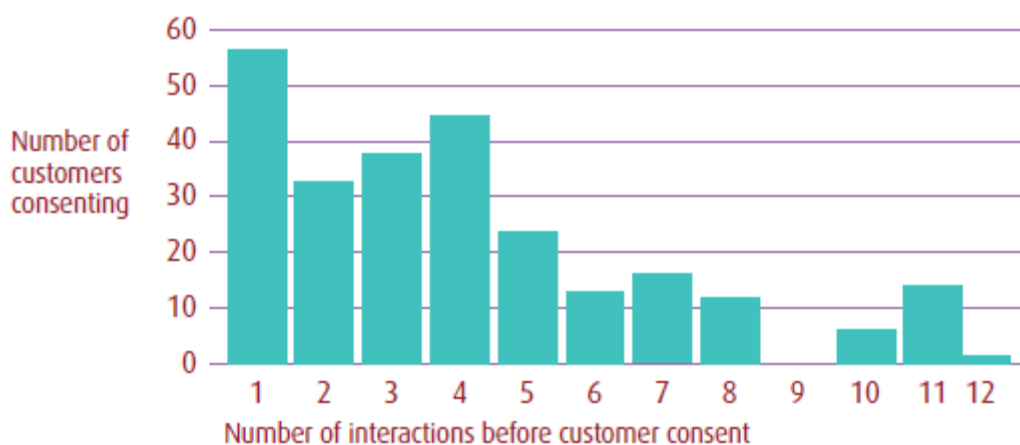


Figure 9: Trial 2 consents.

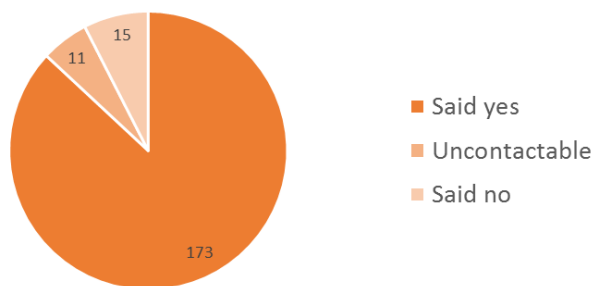


Figure 10: Credit meter sign-up.

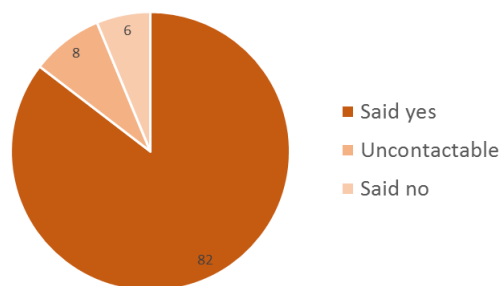


Figure 11: Prepay meter sign-up.

Furthermore, because of the CFOs' excellent knowledge of the project's participants, the recruitment approach could be tailored to the participant (for example phoning or door knocking at times of day the participant was most likely to be in). Both factors contributed to the high sign-up rate for Trial 2.

A recruitment strategy for Trial 2 was developed, incorporating learnings from Trial 1 recruitment including:

- streamlining the installation process to reduce the number of customer interactions; this was implemented part way through Trial 1 installations and continued throughout Trial 2 recruitment and installations;
- increased operational management of the Trial 2 installation phase to enable daily sharing of information between the installation and recruitment partners;
- an improved process for liaising with housing providers to ensure access to meters at install appointments; and
- offering extra Saturday appointments to enable installations to be completed within a relatively short period of time.

In accordance with the project's Communications Plan, key aspects of the recruitment were led by British Gas. Consent being obtained from the energy supplier was a preferable option as Trial 2 involved participants either:

- consenting to switch to a new British Gas tariff (credit customers); or
- consenting to receive notifications that could result in them receiving credits onto their meter from British Gas.

Full details of the recruitment approach for Trial 2 can be found in the **energywise** "SDRC 9.4 – Customer Engagement" report¹⁶.

3.2.1 Trial 2 participants

During the setup of Trial 1, the recruited households were randomly allocated to group 1 (intervention) or group 2 (control), following the random allocation process designed by the research partner. The households recruited within the Padstow House building were assigned to the intervention group in order to test the MDU solution. For the purpose of Trial 2, the distinction between a control and intervention group was no longer necessary (group 1 and 2 were merged in the Trial 2 setup). The design of Trial 2 only distinguishes between meter types (credit and prepayment).

Active participants who consented to Trial 2 had originally been split across the two research groups, with 126 participants in the intervention group and 105 in the control group (which were merged together for the purpose of Trial 2). Overall, the project experienced 273 drop-outs, however the number of participants choosing to leave

¹⁶ "SDRC 9.4 – Customer Engagement", **energywise**, 2016, available from: <http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Energywise/Project-Documents/Energywise+SDRC+9.4+Report.pdf>

the project during Trial 2 was very low with just one participant doing so from July 2017 to March 2018 (other dropouts were due to customers switching supplier or moving house making them ineligible).

At Trial 2 completion, there were 265 participants active in the project, of whom 189 were credit and 76 were prepayment customers. Out of 265 active participants, 231 have consented to trial 2 tariffs, with 162 credit customers signed up to HomeEnergy FreeTime and 69 prepayment customers registered for Bonus Time.

Table 4: Breakdown of Trial 2 participants at the end of DSR trial – March 2018.

	Active participants	Active participants in DSR trial
Credit	189	162
Prepay	76	69
Intervention	151	126
Control	114	105
Total	265	231

The results presented in this report are based on the following datasets:

- The **quantitative analysis of the electricity data** is primarily based on half-hourly reads and is carried out over the 12 months of Trial 2. Data from participants that dropped out from the project before the trial was completed were removed from Trial 2 electricity data analysis for consistency purposes.
- The insights collected through the **research surveys** are based on the data available from a sample of trial participants that were still active at the end of Trial 2. Out of these, 162 were credit customers and 69 prepayment customers.

3.3 EPC rating, Home Energy Survey and household properties

During the customer recruitment and installation process (Trial 1), the project carried out a survey to analyse the composition of participating households to investigate the following:

- Household EPC rating (a household's Energy Performance Certificate indicates how much energy a household may require for heating, lighting, etc.).
- Number of occupants and demographic make-up.
- Ownership of appliances.

It was found that the majority of household had an EPC rating of C or D.

The participants on the **energywise** project have significantly larger households (mean = 3.53) than the general UK population (mean = 2.38, ONS 2014).

Out of the 278 households who have completed the survey, 154 reported that they are receiving housing benefits and 130 (66 in intervention and 64 in control groups) are receiving child benefit. Furthermore, 47 receive income support and 39 are in receipt of other state benefits.

There is a high proportion of Bangladeshi households, which is reflected in a high proportion of participant households speaking Bengali as the primary language at home. Out of the 278 participants who have completed the survey, 114 identified Bengali as the primary language at home.

Table 5 gives an overview of the number and type of appliances present in the average participating household. For a detailed description of household characteristics, including a full analysis on how household properties

compared across the control and intervention groups (only applicable to Trial 1), refer to the Final Energy Saving report¹⁷.

Table 5: Electric appliance ownership

Electric appliance type	Average number of appliances
	N=278
Total Lightbulbs	8.65
Total TVs	1.55
Total entertainment devices	2.75
Total computing devices	2.09
Total ancillary computing devices (e.g. printers etc.)	0.89
Total mobile chargers	2.73
Total wet/dry appliances	1.16
Total cold appliances	1.63
Total (secondary) electric heaters	0.60
Average household size	3.53

3.4 Energy social capital in the trial area

3.4.1 Introduction

Social Capital refers to the social networks, trust and reciprocity of a community (collective social capital) or the resources available in a person's social network (individual social capital). The study undertaken in the **energywise** project researches both individual and collective social capital of the study population, but focuses on one type in particular; energy social capital (ESC). ESC is defined as the information resources related to household energy use embedded in social networks (see McMichael 2011¹⁸). Here ESC is measured through collecting data on:

- Where participants find energy efficiency information;
- Which personal (and non-personal) sources they use to find information; and
- Who participants trust for advice on energy.

This data was collected through a short self-completion survey designed for the project.

energywise participants had received three ESC surveys during the course of the project; the first Energy Social Capital (ESC1) survey was sent at the start of Trial 1, ESC2 just before the start of Trial 2, and ESC3, just before the end of Trial 2. The administration and results of ESC1 are discussed in the "SDRC 9.3 – Results from the first six months of the energy saving trial" report and the "Final Energy Saving Trial Report", the administration and results of ESC2 (including comparisons with ESC1 results) are discussed in SDRC9.4¹⁹. The administration and results of ESC3 are discussed here. The purpose of this iteration was to

- investigate changes over time in participants' ESC resources and how they are used;
- investigate perceptions of the project overall and how these have changed over time; and

¹⁷ "The Final Energy Saving Trial Report", **energywise**, 2017, available from: <http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Energywise/Project-Documents/energywise+Final+Energy+Saving+Trial+report+v1.6+PXM+2017-05-24.pdf>

¹⁸ McMichael, M. (2011) Social capital and the diffusion of energy-reducing innovations in UK households. University College London Energy Institute, Bartlett School of Graduate Studies. London, University College London. PhD: 280.

¹⁹ All reports are available from <http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Energywise/>

- c) follow up on additional questions raised in ESC2 such as knowledge of priority services register.

Attitudes towards the project are analysed first followed by a comparison between the results of the three surveys.

3.4.2 Administration

The ESC3 survey was sent in February 2018 to all 265 active participants (236²⁰ DSR active, and 31 who said no to Trial 2, but remain in the project). 110 surveys were received back (105 DSR active and 5 not DSR active) (Table 6). This gives a response rate of 42% and is around the same as the response rate to ESC1 of 39.7% and to ESC2 of 45%.

Table 6: ESC3 surveys

	Total	DSR Active	Not DSR Active
Mailed	265	234	31
Received	110	105	5
Left project after receipt	0	0	0
Analysed	110	105	5

A total of 110²¹ surveys have been analysed for this report, 105 DSR active and 5 not DSR active.

3.4.3 Attitudes towards the energywise project

Benefits from the project

ESC3 asked 'Considering the project overall, has **energywise** had any benefits for you or your household'? Respondents could tick as many options that applied; 95% of respondents ticked at least one benefit. Figure 12

²⁰ This total includes the three participants who said yes to HEFT, but later switched tariff. These participants were sent the DSR active survey in order to capture their thoughts about the tariff and the challenges they felt it represented. Please note that the number of active DSR participants was 236 at the time of circulating the ESC3 survey (early 2018)

²¹ The dataset is for active participants as of the end of March 2018

below shows the main benefits by meter type. Non-DSR participants are not shown in Figure 12 as there were only five of them in the survey sample.

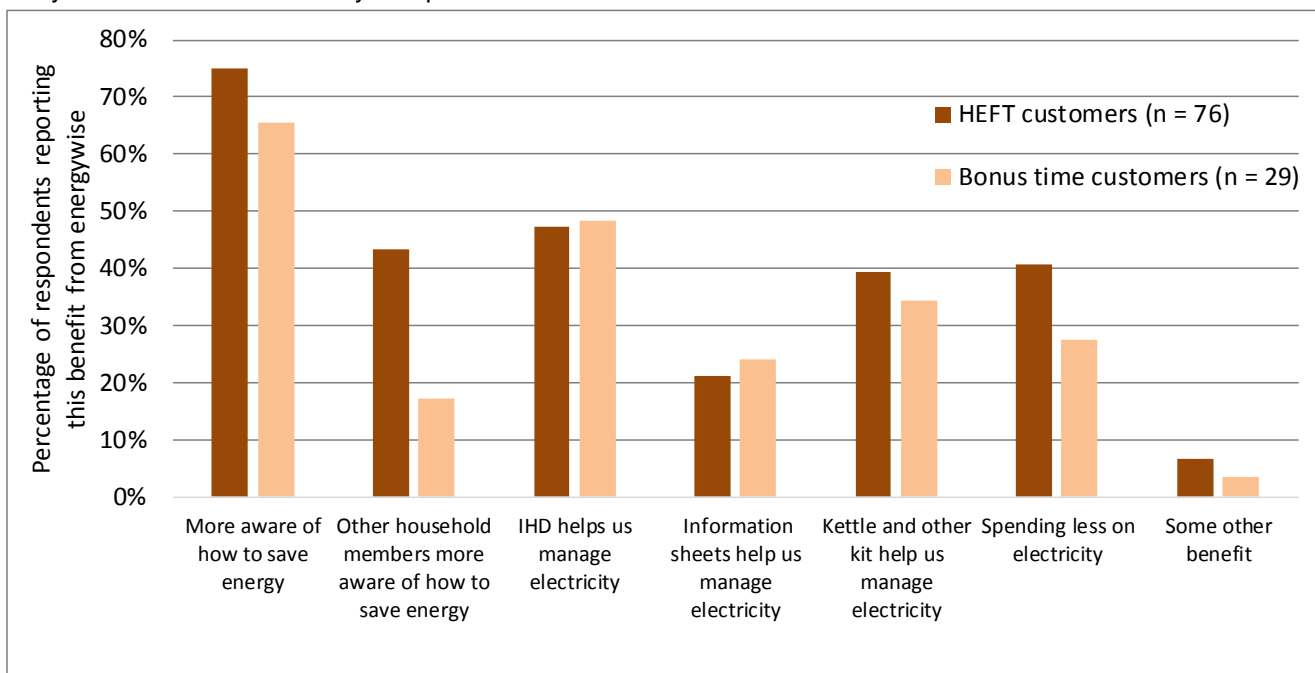


Figure 12: Has energywise had any benefits for you or your household?

Attitudes towards the energywise project

ESC2 asked 'how satisfied are you with being part of the project so far?' 84% (114) of the respondents were either satisfied or very satisfied with the project. This increased to 95% in ESC3 (102 respondents).

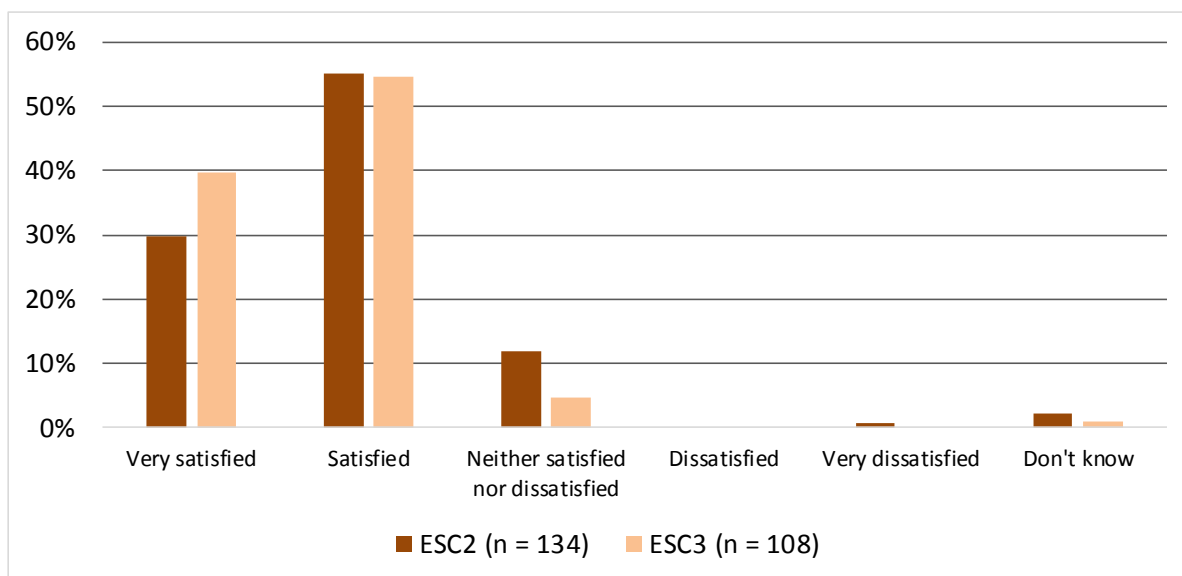


Figure 13: How satisfied are you with being part of the project so far?

Awareness of Priority Services Register (PSR)

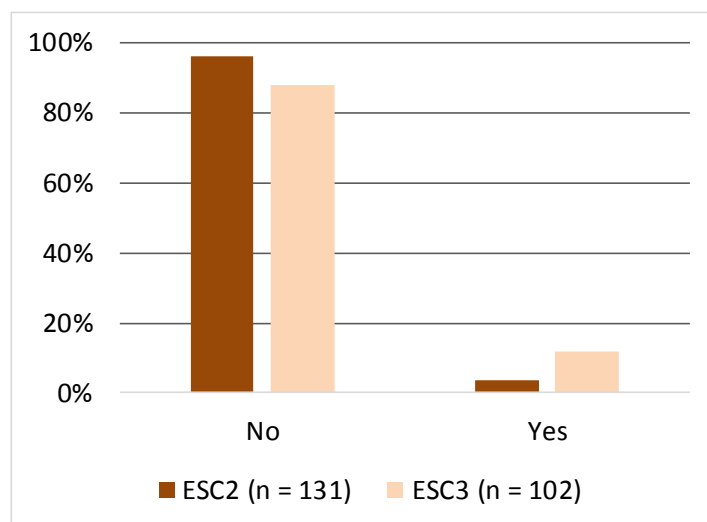


Figure 14. Have you heard of the Priority Services Register?

In ESC2 only 4% (five) of participants had heard of the priority services registers, and all five knew only the British Gas register. No respondents had heard of UK Power Networks' PSR. In response to this low awareness the project included details on the PSR in the October 2017 newsletter. ESC 3 shows that awareness levels have changed. 12% of respondents were aware of the PSR, and most of these stated UK Power Networks' register as the scheme they had heard of (Figure 15). This change in awareness may have arisen from the inclusion of a question on Priority Services Registers in the ESC2 survey itself, or may have arisen from steps taken by the project following ESC2 to raise awareness on PSR. These included providing PSR information for both UK Power Networks and British Gas registers in newsletters issued to all active trial participants.

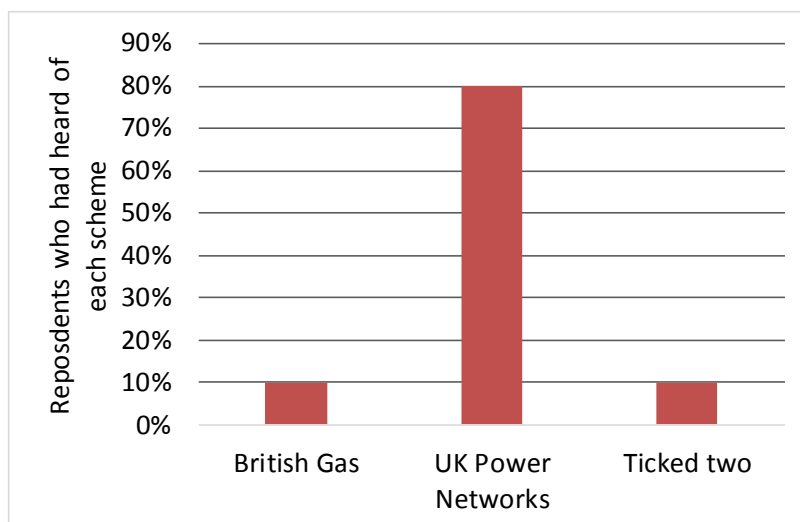


Figure 15. For those customers who are aware of a PSR, which organisation's register have you heard of?

Summary:

- **energywise** continues to be viewed positively by engaged members after more than two years of trial activity
- The main benefits of the project are awareness of how to save energy and assistance in doing so through the in-home display.
- These benefits are similar across the different trial groups.
- The project has slightly improved awareness of the Priority Services Register.

3.4.4 Changes over time in participants' Energy Social Capital

ESC3 was designed to interrogate further the findings of ESC1 and ESC2. This section compares the findings across the three surveys and discusses how participants' Energy Social Capital has changed over the course of the project.

Energy Social Capital Resources

The ESC surveys identify the form of social capital defined as the 'resources available in a person's network'. The more resources available, the more social capital a person is thought to hold; in this case, the more energy efficiency resources that a person holds, the more energy social capital that person is deemed to have.

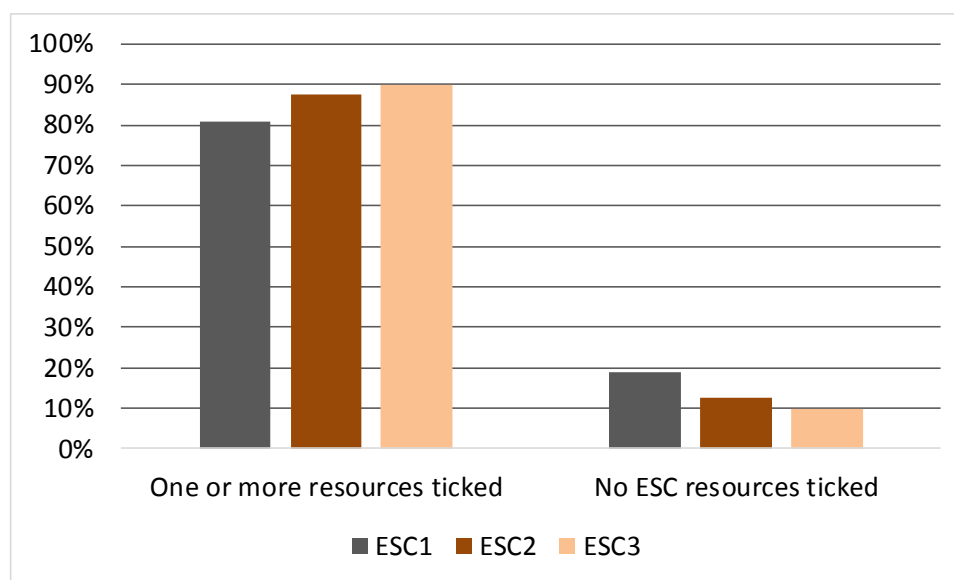


Figure 16: Identifying at least one ESC resource within social networks

All three ESC surveys asked participants if they knew people who they could ask about a range of energy related issues. Figure 16 shows the proportion of participants who could identify at least one person they knew to ask for information in one of the areas listed. Figure 16 shows a gradual increase over time.

The surveys investigated what type of ESC resources were held by respondents by asking if they personally knew someone who could give them advice or information on a range of energy related issues. Figure 17 shows the responses. There were six resources showing a *consistent increase in positive responses* over the duration of the project. There were only three topics in which a consistent increase in positive responses was not observed: knowing an electrician, and knowing someone who would give sound advice on buying electricity saving gadgets or appliances.

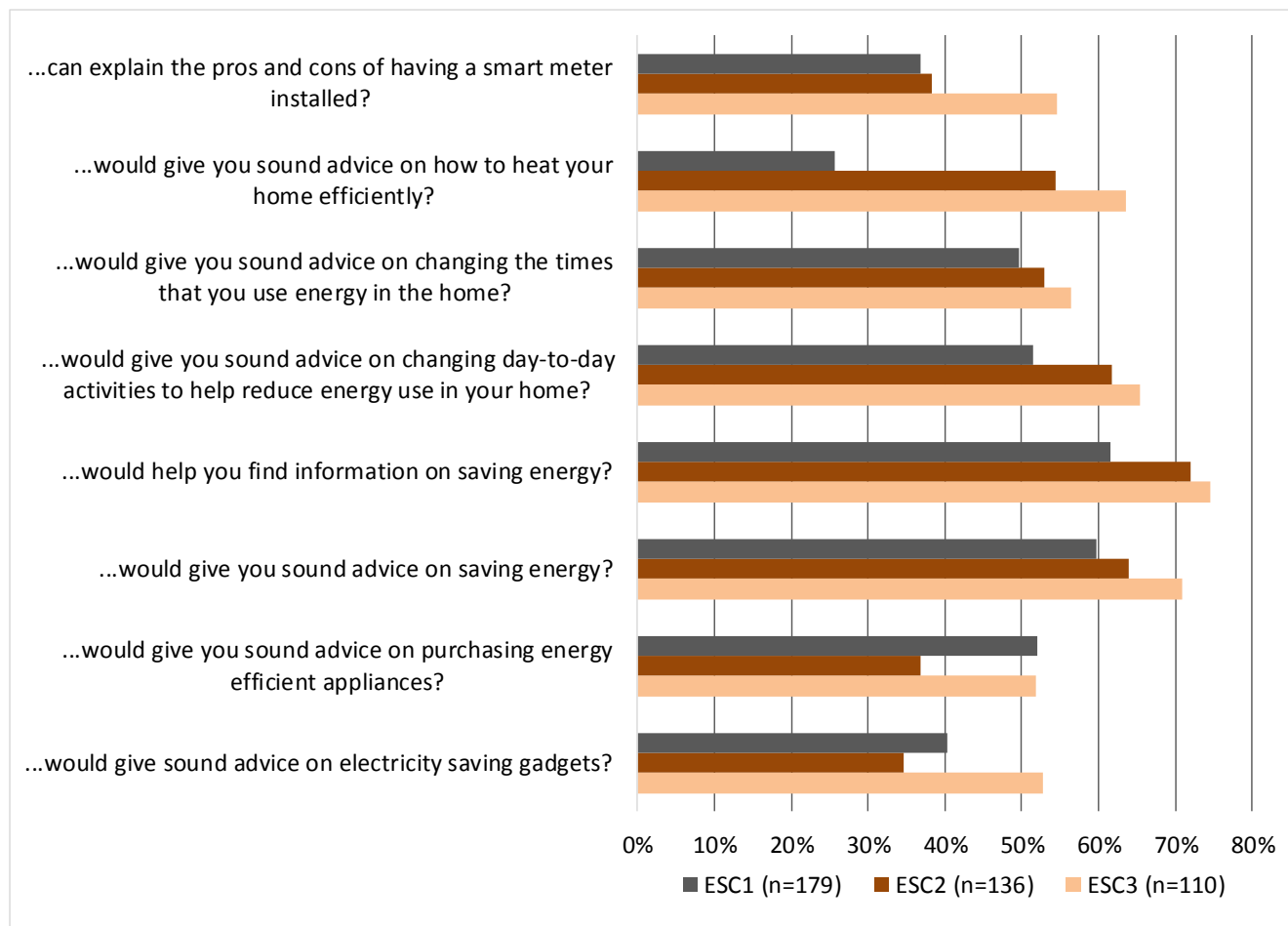


Figure 17: Do you know anyone who...

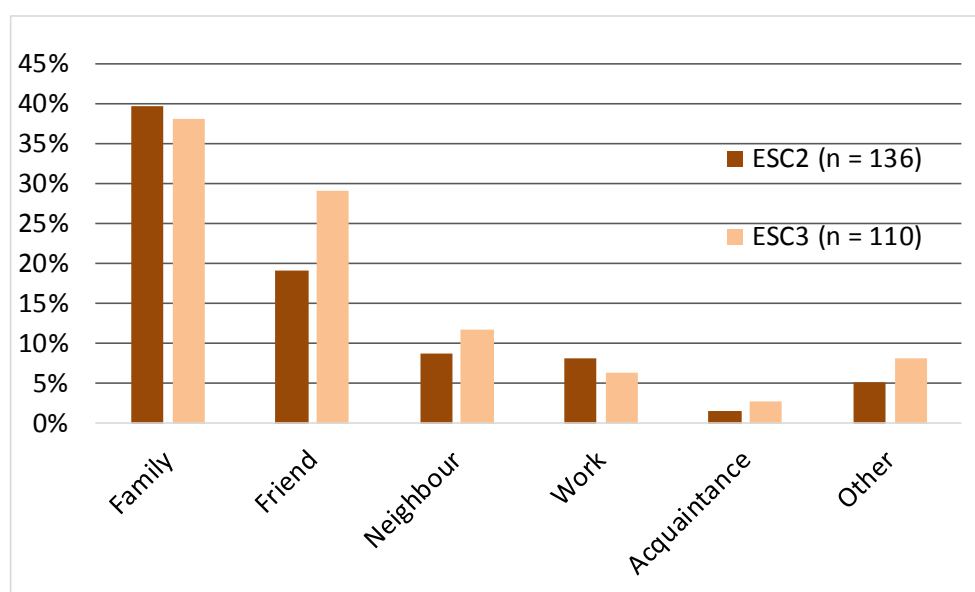


Figure 18. Do you know anyone who would give you sound advice on changing the times that you use energy in the home?

One of the resources which was shown to consistently increase was knowledge of a person who could give advice on changing the times energy is used in the home. This is especially relevant to Trial 2 whose focus was shifting. Figure 18 compares ESC3 (the end of Trial 2) to ESC2 (the start of Trial 2). It shows that this resource is most likely to be a family member, in line with the other ESC resources. However Figure 18 also shows an increase in the proportion of people who could get this advice from a friend.

This question asked people if they know where to turn if they wanted to find out information, in other words it identified hypothetical resources, not those that had necessarily been used. The next section explores whether these hypothetical resources have been put to use.

Information seeking on electricity

The surveys have identified changes in how people put their ESC to use. Respondents were asked to think whether they had discussed electricity with people they know in the past six months. ESC1 captured the six months prior to the start of the project and showed that 45% (80) had had a conversation with one or more people they know in the last six months about electricity, while 45% (81) had not spoken about electricity in the past six months.

This question was repeated in ESC2 and ESC3. It can be seen from Figure 19 that over the entire **energywise** period there has been a drop in the proportion of respondents who have had no conversations from 45% to 19%. In fact the most common number of people that respondents had discussed electricity with in the six months prior to each survey has increased from zero to 2-3.

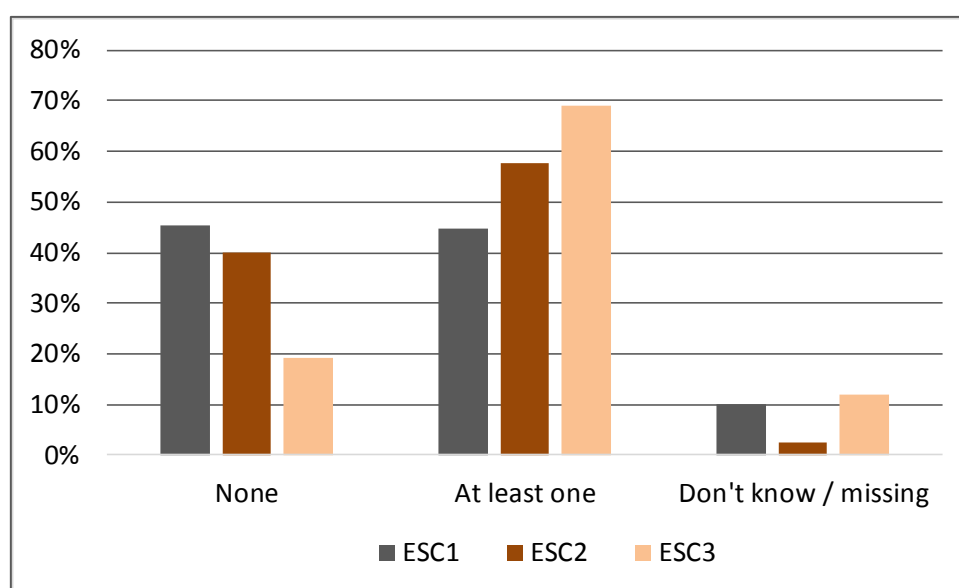


Figure 19: How many people have you discussed electricity with in the past 6 months?

Although there has been a small increase in the number of conversations people have had since the project started, the people that participants discuss electricity with do not seem to have changed.

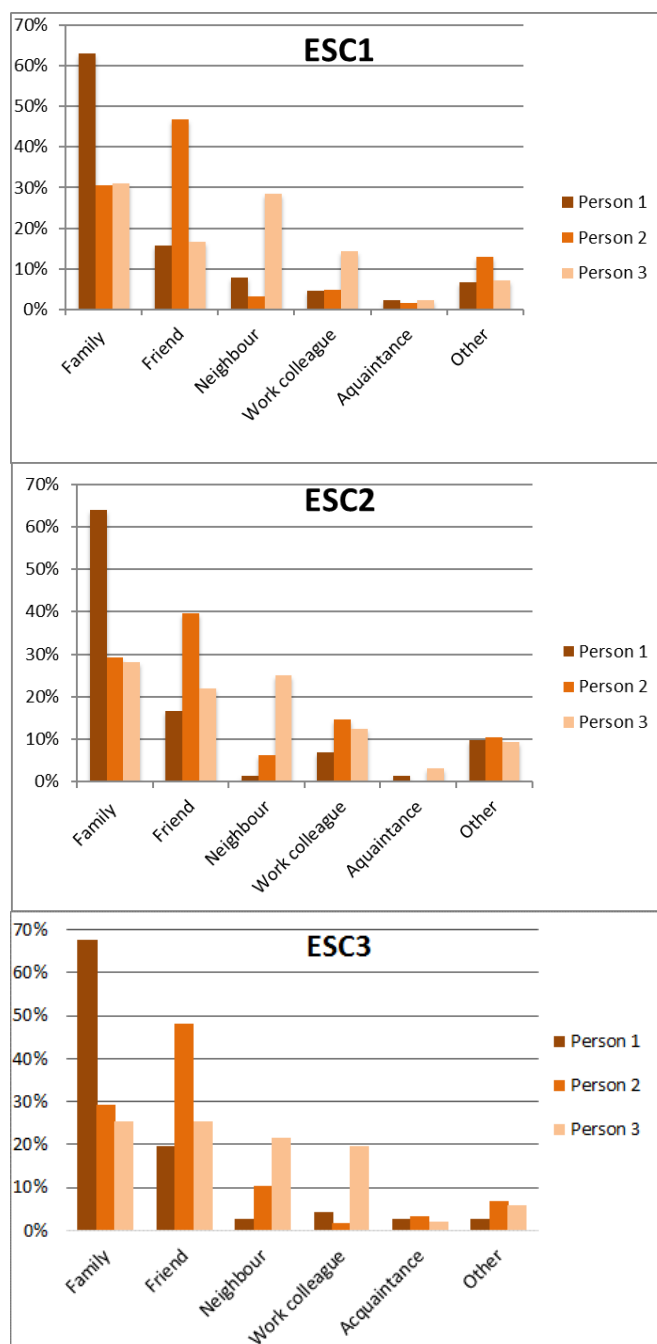


Figure 20. Breakdown of three people that participants discuss electricity with. Showing all three surveys.

Figure 20 shows that at the start of the project the people had had conversations with a family member. If they'd had more than one conversation, it was likely that the second person would be a friend. This continued to be the case in ESC3.

Both ESC2 and ESC3 asked participants what they had discussed. Figure 21 gives the results and shows that energy bills are still the most common topic of discussion but that there has been an increase in conversations about changing the times of using energy.

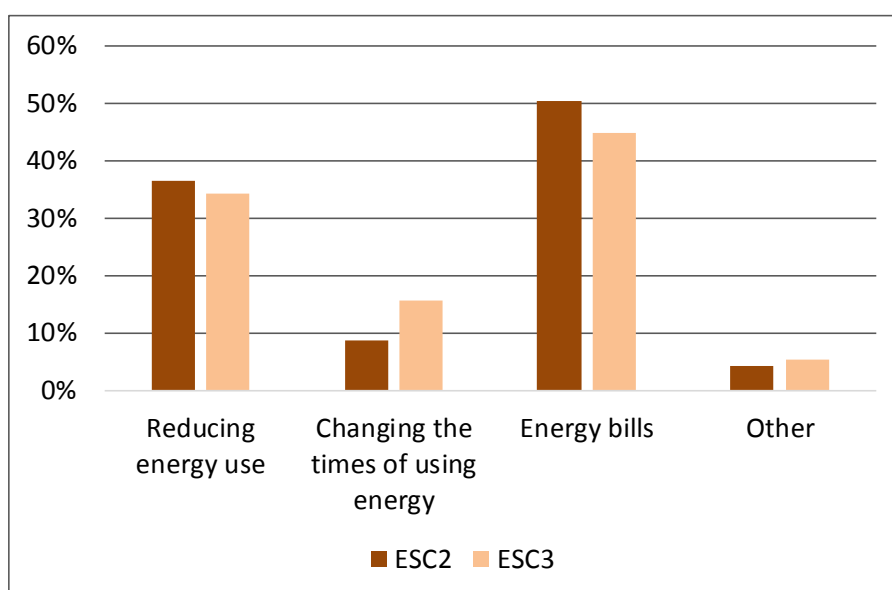


Figure 21. What did you discuss?

ESC1 asked where participants would turn if they had a question about electricity use in the home and found that after the internet, the majority of participants would turn first to an organisation or group, rather than someone they knew. In comparison, ESC2 found that more respondents would turn first to someone they knew rather than turn to an organisation. This continued to be the case in ESC3 (Figure 22).

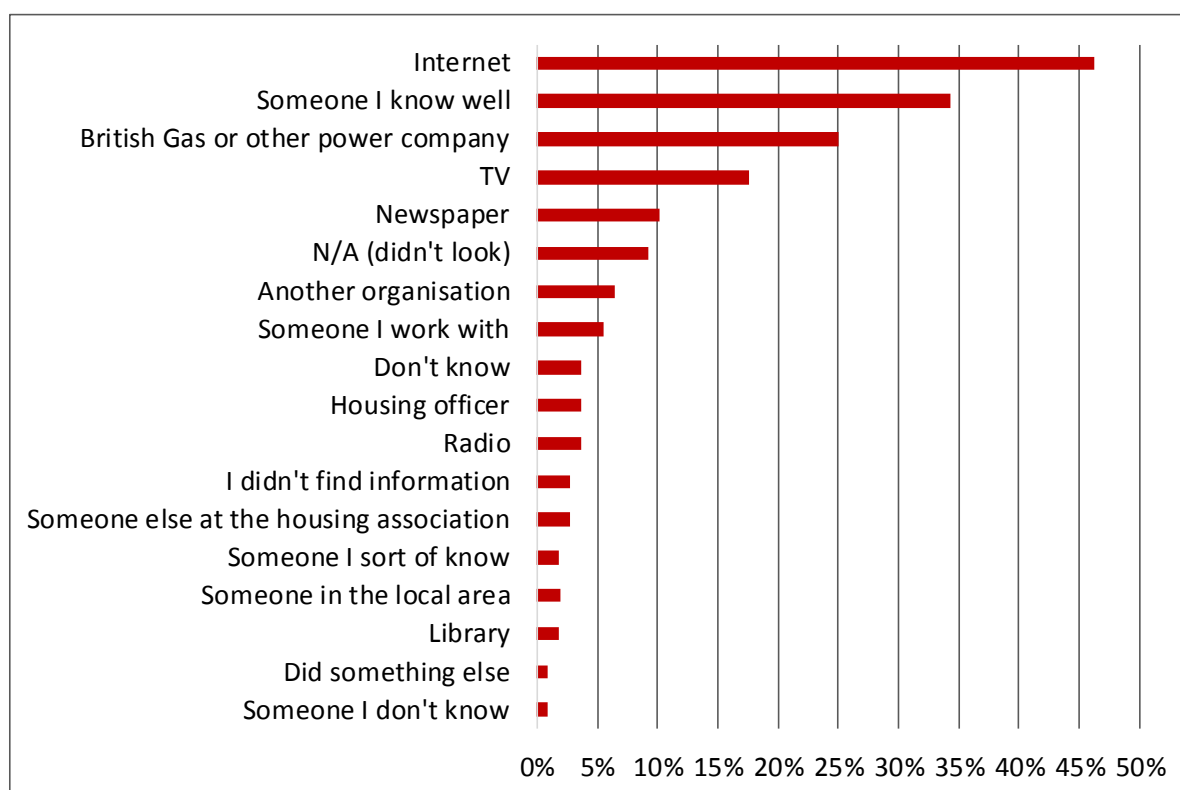


Figure 22. Where would you turn first if you had a question about electricity use in the home?

ESC2 and ESC3 asked about the kinds of organisations that people would approach. Q7 asked 'If you would approach an organisation or group about electricity use, which type would this be? Respondents could pick as many options as applied.

- British Gas (or another power company);
- Distribution Network Operator;
- local council;
- social landlord;
- community-based organisation or centre; or
- other.

Figure 23 shows the findings from the respondents who ticked that they would first approach an organisation. In ESC3 a majority (61%) would approach British Gas; this is similar to the responses in ESC2.

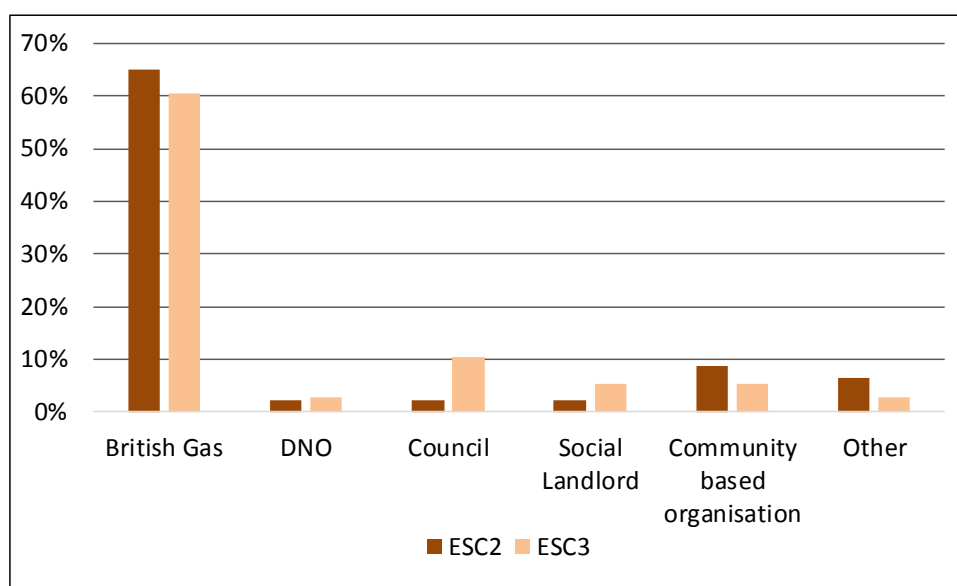


Figure 23. If you would approach an organisation or group about electricity use, which type would this be?

Respondents were asked if they actively seek information about electricity and energy efficiency; this is shown in Figure 24. Although from ESC1 to ESC2 the proportion who look for information increased, this decreased again in ESC3. The proportion of those who said they 'don't get tips or advice' is 12%, in comparison to 21% of ESC1 respondents and 15% of ESC2 respondents.

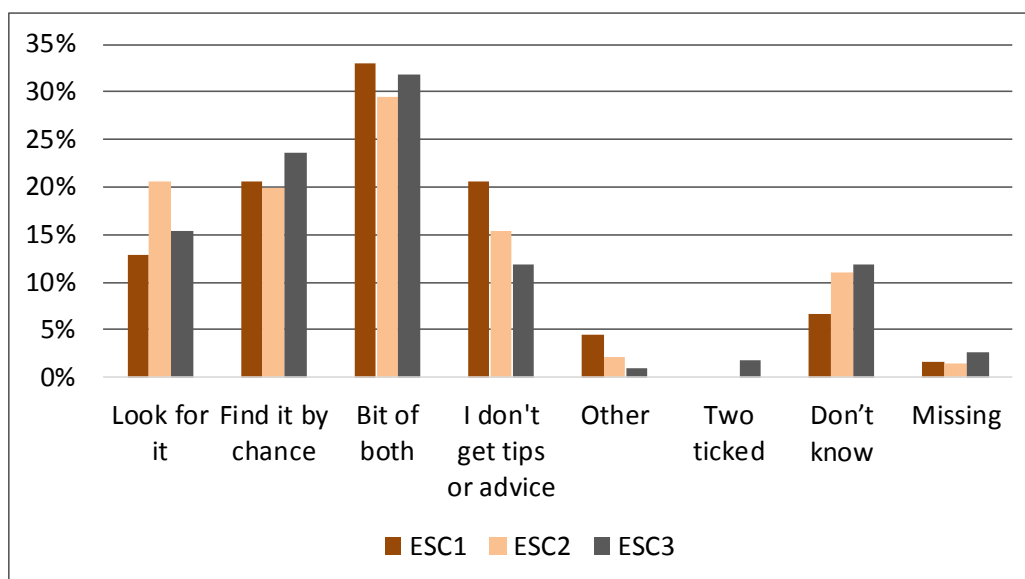


Figure 24: Where do you look for tips or advice?

Summary

Resources

- ESC resources have consistently increased over the project.
- The family has been the most important ESC resource for both groups over the whole project.
- Participants were asked if they knew someone who could advise on particular ESC resources. The proportion of people who did know such a person increased over the project for two thirds of ESC resources.

Information seeking

- The proportion of respondents having had at least one conversation about electricity in the last six months rose over the project. These conversations are still largely amongst family members.
- From ESC2 to ESC3 there has been an increase in conversations about changing the times of using energy.
- From ESC1 to ESC3 there has been a decrease in the number of respondents who would first turn to an organisation to find out about electricity and an increase in turning to a person known to the respondent.
- For those respondents who would first turn to an organisation, they would turn to British Gas.

Concluding points

- Notable increases over the project were the number of people reporting that they have at least one ESC resource, the proportion of people who can explain the pros and cons of having a smart meter installed, the proportion of people who would turn to someone they know to ask about energy issues and the number of people discussing electricity with at least one person. These changes could indicate that being involved in the project, or receiving smart meters, advice and devices has generated more awareness about energy within the household.
- Notable constants over the project are the role of the family as the most important source of information about energy.
- The level of awareness about the PSR amongst the participants is still low but improved over the project.

4 Trial 2

4.1 Trial 2 offer

Trial 2 focuses on Demand Side Response (DSR) and is referred to below as the DSR trial. DSR involves customers being encouraged to lower or shift their electricity use at certain times through various methods (e.g. financial incentives). Under Trial 2, a different DSR intervention has been offered to participants who pay for their electricity through a credit meter and those who have a prepayment meter. Trial 2 participants were recruited from existing **energywise** participants.

4.1.1 Prepayment customers – Bonus Time

Prepayment customers were offered Bonus Time – a dynamic, non-punitive, Critical Peak Rebate scheme in which customers who reduced their electricity demand during pre-notified time periods were rewarded with additional credit on their meters. The price for electricity during these periods remained the same but each customer was credited 10 units back for every unit of energy they saved within the Bonus Time period (Figure 25). Notifications were provided via SMS (plus email where desired).



Figure 25: Bonus Time

4.1.2 Credit customers – HomeEnergy FreeTime (HEFT)

Credit customers were offered HomeEnergy FreeTime – a static, non-punitive, Time-of-Use tariff. This tariff offered the smart credit metered customers the choice to decide whether they wanted to receive free electricity on Saturdays or Sundays between 09:00-17:00 (Figure 26). Compared to the HomeEnergy FreeTime offers commercially available, the tariff will not have exit fees, will be available also to customers that are on paper billing and to those who are supplied gas by another supplier to ensure that all the **energywise** participants can benefit from it.



Figure 26: HomeEnergy FreeTime tariff

Prior to the start of Trial 2, all active participants were invited to take part in Trial 2 by either:

- agreeing to receive Bonus Time notifications (prepayment customers); or
- agreeing to switch to the HomeEnergy FreeTime tariff (credit customers).

Customers not wishing to do this remained **energywise** participants (provided they either already had or agreed to have a smart meter installed), but they were not participating in the DSR trial.

4.2 Trial 2 interventions

4.2.1 Control group customers

Control group customers received the following either just prior to or post Trial 2 recruitment as per the research trial design described in Section 2.3:

- their energy efficiency devices and energy efficiency advice leaflet, delivery of these commenced just prior to Trial 2 recruitment;
- their smart meter and Smart Energy Monitor which was provided soon after they had signed up to take part in Trial 2; and
- energy efficiency advice – this was split into two documents, with advice about the devices being provided when those devices were delivered and advice about the Smart Energy Monitor provided after that device had been installed.



Figure 27: Energy efficiency devices & energy efficiency advice leaflet

Multiple Dwelling Units

Three participants remained active in Padstow House until the end of Trial 2, who required the MDU solution to use their Smart Energy Display. No further interventions were conducted at Padstow House and the MDU solution remained unchanged.

Energy efficiency appliances

Before the start of Trial 2, all active participants were offered one additional LED light bulb (in addition to the three LED light bulbs that were provided at the start of Trial 1). 206 households received the fourth LED bulb.

5 Customer insights

5.1 Electricity data

The analysis in this section uses half-hourly data from the smart meter of each participant in Trial 2, from April 2017 to March 2018 inclusive. As outlined in SDRC 9.4, the smart meter data was stored in the British Gas reading repository, some basic processing was carried out, then the data was transferred to University College London and Element Energy every month for further data cleaning and analysis. The half-hourly smart meter data was analysed on a monthly basis over the course of the trial. Checks were implemented that revealed erroneous data which did not accurately represent customer behaviour. The analysis presented in this report is based on the data that was obtained after carrying out several data cleaning steps. In order to make best use of the available data, households were not excluded entirely from the analysis (unless they dropped out of the trial, in which case they were excluded from the analysis dataset), data was only removed for those periods of times when the data was corrupted. Any data relating to the following issues was removed from the analysis dataset:

- Zero or missing readings;
- Duplicate readings;
- Negative values;
- Frequent jumps between negative and positive reads (it was found that the remaining positive values were not accurately describing customer behaviour during such periods);
- Values that were not reported at a 30 minute resolution; and
- Spikes to very large values. The threshold was set at consumption reads above 15 kWh/half-hour.

5.2 Analysis methods for determining responses

This chapter focusses on electricity shifting from a customer perspective. The evaluation of the two intervention types (Bonus Time and HEFT) used different metrics of 'shifting' and required different methods to calculate each participant's response. Both methods were devised to enable per-household responses to be ascertained solely using historic data from the household in question, without the need for other participants or a control group. This method, called 'within subject' analysis, was used for two reasons. Firstly, as part of the trial design, it was decided for participant equity reasons that in Trial 2 all participants should receive the advantages of the energy saving and energy shifting interventions. Because of this a Randomised Control Design with an internal control group would not be used, and all analysis should be made by comparing pre and post intervention data for the same participant. This minimises the variation that arises when comparisons are made between subjects, but introduces the possibility that external factors (such as price rises) may distort the results.

5.2.1 Bonus Time intervention

The metric of 'shifting' in the Bonus Time context is how much a household reduced their electricity consumption during the Bonus Time events, expressed in Wh per event. The data available shows how much electricity was used during each event; however a prediction must be made of how much the household would have used in the absence of the event. This hypothetical prediction is called the *baseline*, and it is used to quantify the customer response during the Bonus Time events. This baseline is derived from historic customer smart meter data, in line with previous trials in the United States²².

Each household was posted a statement every three months showing the number of kWh shifted and the amount of money rebated onto their meter during that time, as well as the total kWh and equivalent number of washing machine loads from all participants during that time.

The results given in this report only concern weekday evening Bonus Time events of six hours' duration since these are particularly relevant from a peak demand perspective and hence were the most frequently tested event timeslot to ensure a sufficiently large sample size for appropriate impact analysis. The weekday evening events

²² 2013 Load Impact Evaluation of Southern California Edison's Peak Time Rebate Program, Nexant, 2014, available from https://library.cee1.org/sites/default/files/library/12425/2013_SCE_PTR_Load_Impact_Evaluation_-_Final.pdf

(17:00 – 23:00) accounted for 52 of the total 66 Bonus Time events that took place across the 12 months of Trial 2²³. Establishing the customer response in Wh per event involves averaging over the whole event to calculate savings during this period for the customer. This differs from the metric used in Chapter 7, ‘Network Insights’, which uses peak demand reduction (i.e. the amount by which the maximum customer demand is reduced).

5.2.2 HomeEnergy FreeTime trial

The metric of ‘shifting’ in the HEFT intervention could be defined in several different ways depending on the research question. The metric used in this chapter is centred around the customer and any savings they made.

HEFT customer metric: kWh per week shifted from the paid period into the free period. For the customer this corresponds to electricity bill reduction. Note that this metric is not the same as extra free electricity used during the free period (see Chapter 6) as this does not correspond to electricity bill reduction.

In a similar manner to the Bonus Time calculation, it was necessary to make a prediction of the counterfactual electricity consumption in the absence of the HEFT tariff in order to ascertain shifting. Using the customer metric as an example, kWh consumed during paid/free times had to be predicted for the same year (April 2017 - March 2018) but as if the tariff had not been applied. It was not adequate to simply use kWh used during paid/free times the previous year (April 2016-March 2017), as year on year changes in consumption could dominate the effect of the HEFT tariff.

This is illustrated using two contrasting examples. Figure 28 shows a time series of daily data from a participant who clearly took advantage of the HEFT offer – the red dots for each free day clearly depart from the usual pattern of consumption. Figure 29 shows a participant whose consumption on the HEFT free days does not indicate a response; in this case, the change between the green and red dots is simply reflective of the general consumption shown by purple dots. These figures together show the importance of taking historical and contextual data into account when trying to ascertain whether the tariff produced a response.

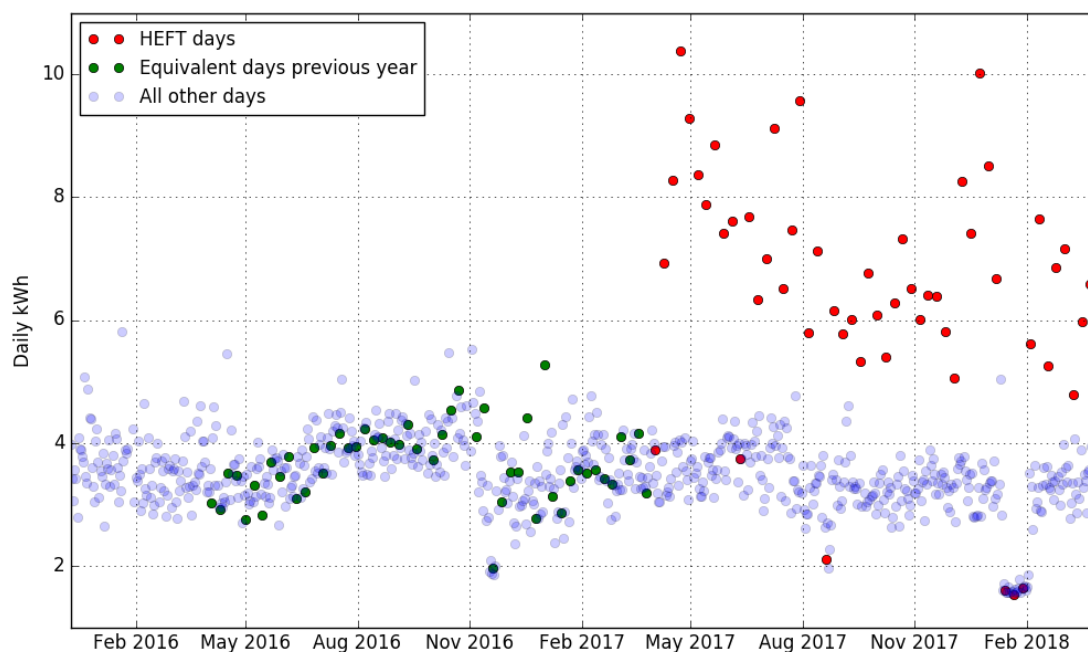


Figure 28. Example of clear response to HEFT from one participant.

²³ The 14 Bonus Time events that occurred outside the weekday evening peak were distributed across weekdays (08:00 – 10:00 events and 11:00 – 15:00 events) and weekends (12:00 – 15:00 events and 17:00 – 23:00 events).

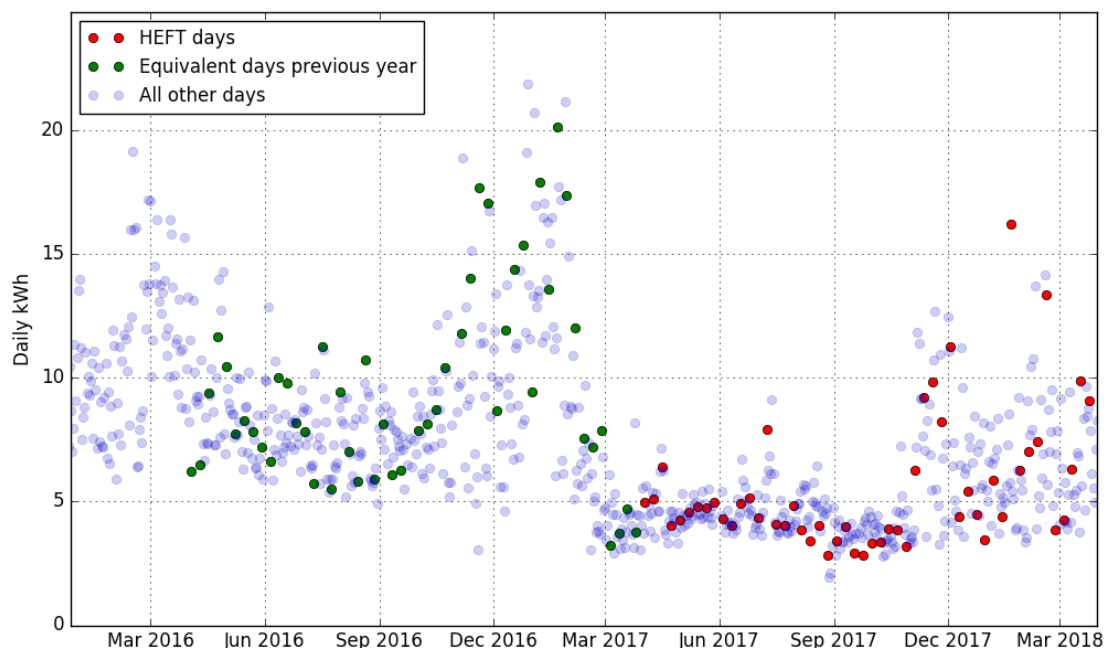


Figure 29. Example of lack of response to HEFT from one participant.

Therefore the change in kWh used during paid/free times from the previous year to the HEFT year was adjusted for general changes in consumption. This adjustment process is illustrated in Figure 30 for an example participant, marked with a dot.

The grey arrow from the horizontal line down to the dot shows a decrease in the participant's electricity consumption during *paid times*. If their free time was Saturday 9 a.m.-5 p.m., then *paid times* is all of the week except this eight hours. With 168 hours in a week, participants pay for 160 hours, and receive eight free hours. This example participant has reduced their consumption during paid times.

The line marked 'baseline' represents the fact that if a household decreased their electricity use during paid times but also decreased their consumption in general by the same proportion, the decrease during paid times should not be taken as the effect of the HEFT tariff. This is the line of equal proportional change of consumption during paid times and for the whole week. For example, if a participant reduced their consumption by 3% during the period they paid for (160 hours), and by 3% over the whole week (168 hours), they did not respond to the tariff despite reducing consumption during the paid period. The equation of the line of equal proportional change in consumption is the ratio of hours of paid time in a week to total hours in a week.

The pink arrow then represents the fact that a portion of the observed decrease during paid times (grey arrow) is likely to be accounted for by general decrease in consumption from the pre-HEFT year to the HEFT year. In the case of the participant in Figure 26, it's clear that overall consumption has dropped during the Trial 2 year (i.e. red and purple dots in April 2017-March 2018 are generally lower than the green and purple dots in April 2016-March 2017). To demonstrate shifting out of the paid period during Trial 2 (April 2017-March 2018), the purple dots (160 hours) must have fallen by an amount greater than that of the red and purple dots (168 hours).

The green arrow in Figure 27 represents this additional fall in the 160 hour paid period, and is the portion of the decrease which is not explained by general change – and is thus hypothesised to be the effect of the tariff.

Note that this is not a perfect method since it is impossible to fully separate the tariff effect from year-on-year general change without the use of a properly randomised control group.

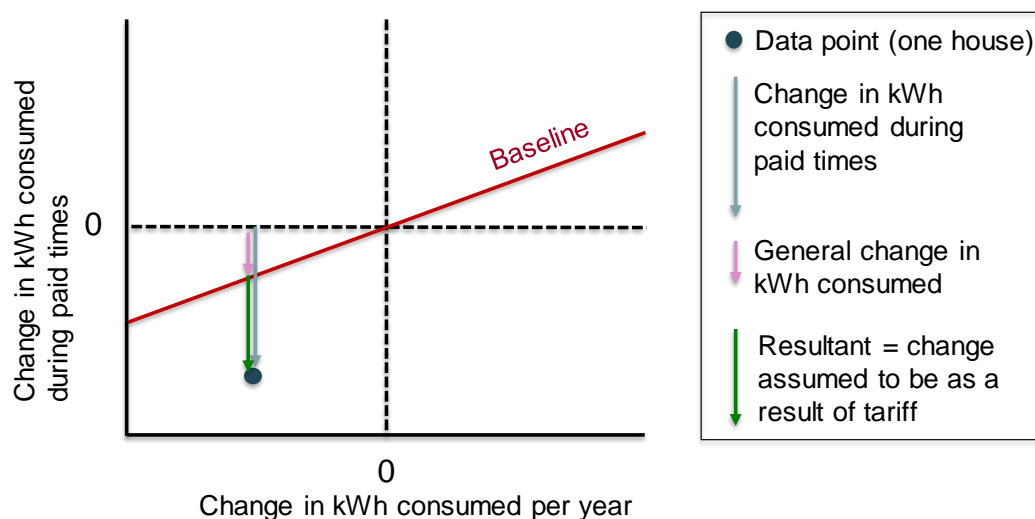


Figure 30. Illustration of calculation of shifting according to the HEFT customer metric.

5.3 Trial 2 energy shifting: results

5.3.1 Bonus Time

The distribution of mean responses per household is shown in Figure 31. The x-axis is increase in consumption during evening Bonus Time events, so 'shifting' out of the evening peak hours is represented by negative data points. The mean household response is -7 Wh.

Since this distribution is approximately normal, a one-sample T-test can be used to test whether the mean is different from zero. This gives the finding that the average response from the group of prepayment customers over the entire Bonus Time period is not significantly different from zero: the difference of the mean from zero is 7 Wh whilst the standard error on this is 22 Wh. However, as is covered in more detail in Section 6.3.2, the demand shifting response of Bonus Time participants appears to be front-loaded within the six hour Bonus Time evening event period and there is a statistically significant reduction in the peak demand (i.e. maximum demand observed across the Bonus Time period) in this trial.

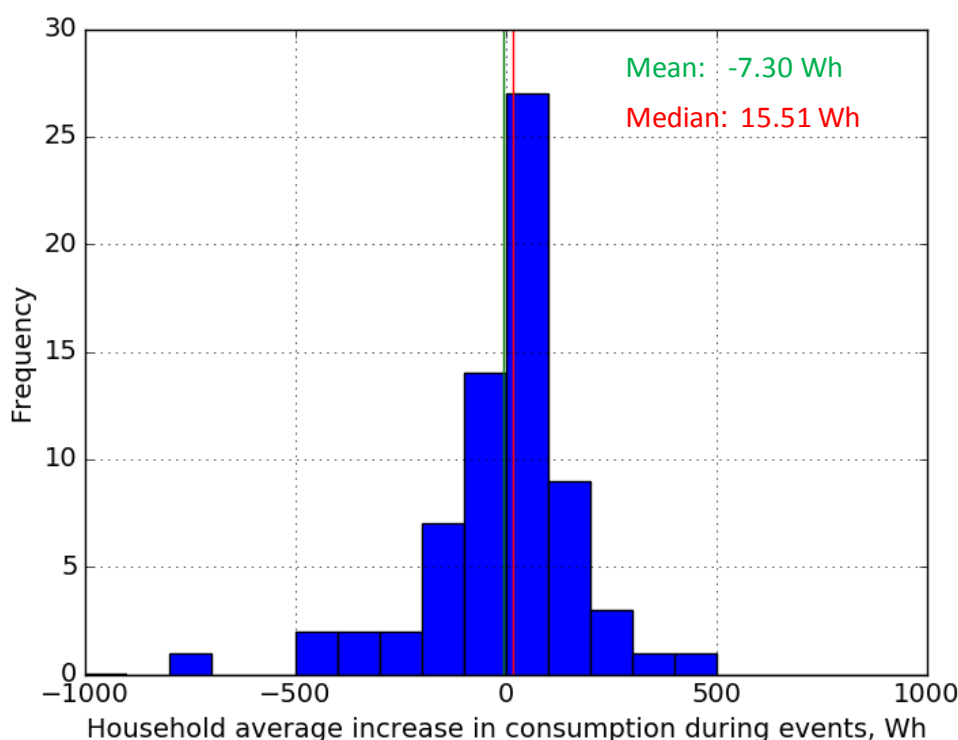


Figure 31. Distribution of per household Bonus Time responses.

The centering of the distribution in Figure 31 around zero implies either high variability in the response of different households to Bonus Time events or the presence of noise in the process used to calculate them²⁴. The qualitative insights in Section 5.4 discuss the former, for example some participants believing they should increase their electricity consumption during Bonus Time events²⁵. However, Figure 31 has a tail at the left in which a group of participants on average shifted several hundred Wh during events. It is worthwhile to try to ascertain whether the households who demonstrated shifting are associated with certain characteristics.

The characteristics chosen fall under three aspects of flexibility capital:

- *Appliances*: ability to shift electricity use is clearly dependent on having loads to shift;
- *Time flexibility*: being able to carry out activities at different times of day or week to usual;
- *Knowledge/motivation*: knowing about and wanting to shift electricity consumption.

It was not possible to have perfect knowledge of the appliances, time flexibility and knowledge/motivation of each household. However for those households which filled in either the Home Energy Survey or the Energy Social Capital Survey, relevant variables were available.

Linear regression was carried out to test for associations between Bonus Time shifting and a set of survey variables listed in Table 7. Linear regression was suitable due to the approximately normally distributed residuals (in other words, each group is approximately normally distributed around its mean). The critical p-value chosen to indicate significance was 0.25 as this was the value used in previous **energywise** reports. However the reader is encouraged to interpret the results for themselves without relying on the critical p-value.

²⁴ It is a known limitation of CPR schemes such as Bonus Time, that there is a component of variability that contributes to the observed response during events. That is to say, no matter how accurate a baselining method is used, there will always be inherent fluctuations in household demand from day to day that are unrelated to a household's response to a critical peak event. Since the Bonus Time scheme is non-punitive and only awards demand reductions during critical peak events, this natural variability (or "noise") will contribute to the rebates rewarded.

²⁵ This was mitigated through a number of actions; the text message informing customers of Bonus Time events was worded to make it very clear that customers were encouraged to REDUCE consumption during Bonus Time periods (with the word reduce in capitals). In addition, the Customer Field Officer team sent out a text to all Bonus Time participants asking them to confirm they had correctly understood the rebate; those responding confirmed they had understood correctly.

Table 7 shows that out of the characteristics tested, two significant associations were found from the appliances category: presence of tumble dryer and presence of electric cooker were both associated with shifting. One significant association was found from the time flexibility category: presence of an occupant aged over 65. No significant associations were found from the knowledge category.

Table 7. Associations between Bonus Time responses and household characteristics.

Category	Variable	Significant association at $p = 0.25$ level?
Appliances	Presence of electric cooker	Yes: significant decrease in peak ($p = 0.07$)
	Presence of tumble dryer	Yes: significant decrease in peak ($p = 0.22$)
	Presence of electric secondary heating	No ($p = 0.52$)
Time	Presence of children	No ($p = 0.37$)
	Presence of adults aged over 65	Yes: significant decrease in peak ($p = 0.05$). However sample size was four high shifters.
	Number of occupants	No ($p = 0.79$)
Knowledge/motivation	Attendance at focus group	No ($p = 0.26$)
	Knowing someone to ask about energy issues	No ($p = 0.47$)
	Looking for information	No ($p = 0.79$)

5.3.2 HomeEnergy FreeTime

The datapoints and distribution of shifting calculated using the HEFT customer metric are shown in Figure 32 and Figure 33 respectively. Refer to Figure 30 for an illustration of the calculation method.

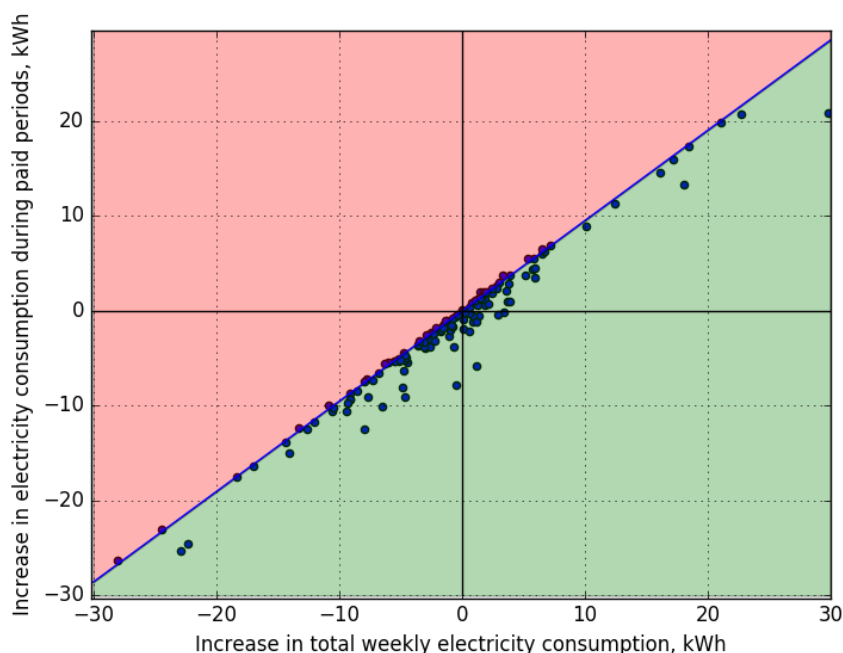


Figure 32. Household responses to HEFT (customer metric) are calculated by vertical distance from each point to the blue line (the baseline).

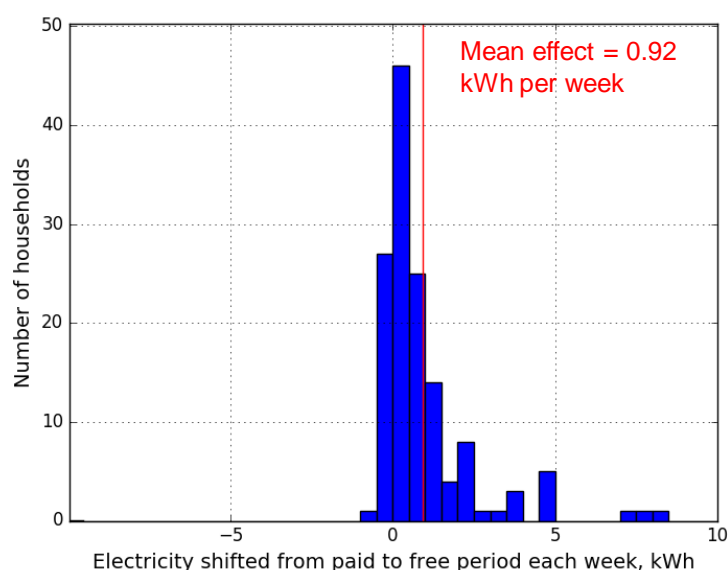


Figure 33. Distribution of household responses using HEFT customer metric.

Unlike the distribution of Bonus Time responses, Figure 33 is clearly non-normal, implying a signal in the data. The mean shifting from the paid to the free period is 0.92 kWh per week per customer. This is 2% of the average weekly consumption.

Next, it is investigated whether shifting is associated with the household characteristics tested in the Bonus Time analysis. Due to the non-normality of the data, linear regression is not suitable. Instead, a Kruskal-Wallis test was used²⁶; this is a nonparametric test comparing group medians to one another. The Kruskal Wallis test produces

²⁶ For the variable 'number of occupants', the Jonckheere-Terpstra test was used as the Kruskal-Wallis test does not allow for ordinality (orderedness) of categories.

a p-value analogous to that in parametric tests but less easy to interpret, therefore again caution should be exercised in results that are near the critical p-value.

Table 8. Associations between HEFT responses and household characteristics.

Category	Variable	Significant at p = 0.25 level?
Appliances	Presence of electric cooker	No (p = 0.59)
	Presence of tumble dryer	Yes: significantly more shifting (p = 0.02)
	Presence of electric secondary heating	Yes: significantly more shifting (p = 0.17) ²⁷
Time	Presence of children	No (p = 0.55)
	Presence of adults aged over 65	Yes: significantly less shifting (p = 0.06).
	Number of occupants	Yes: significantly more shifting up to 6 occupants (p = 0.14)
Knowledge/motivation	Attendance at focus group	No (p = 0.68)
	Knowing someone to ask about energy issues	No (p = 0.92)
	Looking for information	No (p = 0.80)

5.3.3 Discussion of energy shifting results

A group level effect was easier to observe in the HEFT intervention than Bonus Time. In the case of HEFT, where a statistically significant response was observed, the mean shifting from the paid to the free period was 0.92 kWh per week per customer, which corresponds to around the consumption associated with an average washing machine cycle and a saving of approximately 12p/week. The reasons for this are unclear; possible explanations could include HEFT being an easier type of shifting for occupants to carry out than the more dynamic Bonus Time, or the level of variation in weekday evening peak demand rendering shifting difficult to observe.

Associations were found between both types of shifting and factors from the 'appliances' and 'time flexibility' categories. Bonus Time shifting was associated with presence of electric cooking facilities and presence of a tumble dryer, both of which are large loads. This gives indicative evidence that households could be shifting the times at which they cook and dry clothes as a result of Bonus Time. HEFT shifting was not associated with presence of electric cooking facilities, which makes sense as inter-day shifting of cooking is not especially feasible. HEFT shifting was however associated with tumble drying; Section 5.4 relates this to both the participants' experiences and the literature which identifies washing as a shiftable load. HEFT shifting was also associated at the p = 0.17 level with presence of electric secondary heating, however the two distributions looked similar which may indicate that the use of critical p-value of 0.25 is not appropriate in this case.

²⁷ For this variable (whose effect size was 0.24 kWh), the distribution of shifting of participants with and without electric secondary heating appeared similar so whilst this result is technically significant according to the critical p-value, the difference between groups does not look practically significant.

The demographic make-up of the household yielded several interesting associations with shifting. Bonus Time shifting was associated with presence of adults aged over 65, although this result arose from a sample size of only four high shifters, so should be treated with caution. It is possible that retired people have more ability within a day to shift their energy consuming activities. The opposite was true in the case of HEFT: shifting from paid times to free times was less amongst households with over 65s present. More HEFT shifting was also associated with households with higher numbers of occupants. This is further discussed in Section 5.4 in which it is shown that participants sometimes perceive larger households to have more shiftable loads.

Further work could use a control group as part of the baseline calculation for both the Bonus Time and HEFT calculation methods. However when (as shown in Section 5.4) the intervention group is not representative of the control group, this renders the analysis complicated²⁸.

5.4 Statistical generalisation

This section discusses whether the results in Section 5.3 generalise from the **energywise** participants to other fuel-poor communities across Great Britain. Discussion of generalisation in this context relates to the issue of external validity: as Campbell and Stanley note: “‘External validity’ asks the question of generalizability: to what populations, settings, treatment variables, and measurement variables can this effect be generalized?” (1963, p5)

Note that analysis was provided in the **energywise** Final Energy Saving Trial report²⁹ (provided in Appendix A for the sake of completion) of possible exogenous factors and contamination effects adversely impacting on the findings from Trial 2. With respect to the possible impact of exogenous factors impacting on the findings from Trial 2, it is important to note that Trial 2 tested mechanisms to shift energy. Any such exogenous factors, such as changes in the price of energy, would be expected to impact on energy savings – not energy shifting. Any economic response would be expected equally across all periods during the week (i.e. not expressed in differential changes during peak times or on weekends as tested in Trial 2). There is therefore no reason to believe, either from the data or from theory, that external events have influenced the findings of Trial 1 or Trial 2 of **energywise**.

5.4.1 Introduction

To understand how these results may be generalisable to the whole population, the energy consumption of participants in the **energywise** trial is compared with those in the external control group (ECG). ECG participants were recruited (as closely as available data would allow) using the same demographic characteristics as those in the **energywise** trial. For further detail on the external control group refer to Appendix A. To determine their initial similarity, this first analysis is done using Trial 1 data (April 2016-March 2017). In order to increase the sample size of **energywise** participants, it was decided to group those in the Trial 1 intervention and control groups. Note, this is a conservative assumption, as it is known that those in the intervention group in Trial 1 reduced consumption by 3.3% – thus inclusion of these participants provides a lower bound on the energy consumption of the **energywise** participants as a group.

5.4.2 Data

Table 9 outlines the steps taken to arrive at the final samples for comparison, and the size of the sample at each step. Participants with any negative or zero readings are removed due to the skew and uncertainties caused by imputing values in their place. Data quality checks were performed to ascertain that there were no duplicates or improbably high values.

²⁸ Schofield J. Dynamic time-of-use electricity pricing for residential demand response: Design and analysis of the Low Carbon London smart-metering trial. 2015.

²⁹ “The Final Energy Saving Trial Report”, **energywise**, 2017, available from:
<http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Energywise/Project-Documents/energywise+Final+Energy+Saving+Trial+report+v1.6+PXM+2017-05-24.pdf>

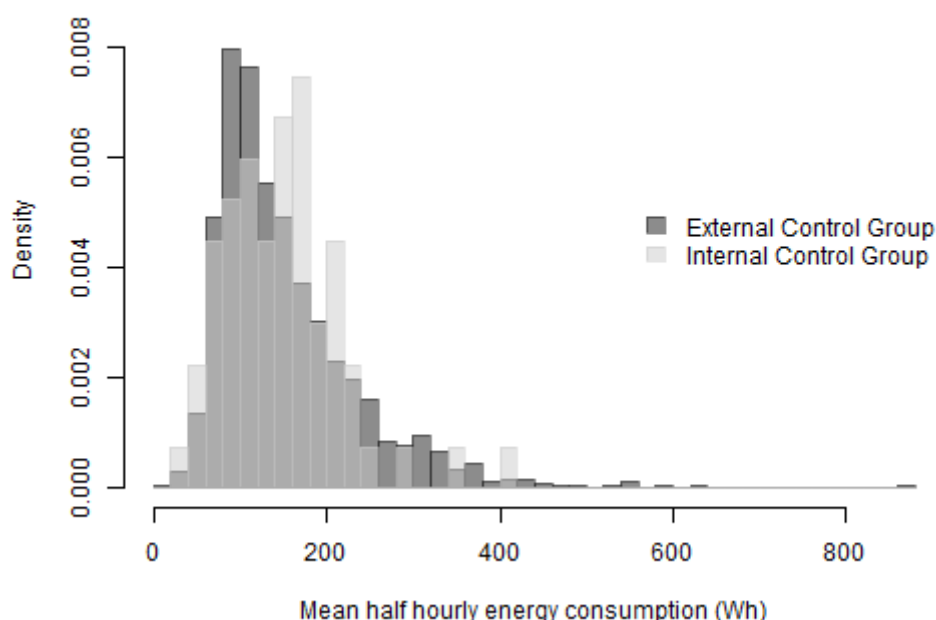
Table 9: Data cleaning steps

Data cleaning steps	energywise size after each step	ECG size after each step
1. Raw data (April 2016-March 2017)	259	4,137
2. Exclude participants with any readings ≤ 0	172	1,932
2. Exclude participants with more than 2% of the readings missing ³⁰	144	1,867

To distinguish the dataset after data-cleaning from the broader **energywise** dataset, it is henceforth referred to as the Internal Control Group (ICG) and refers to the sample of 144 participants. The term ECG is used to refer to the External Control Group sample of 1,867 participants.

5.4.3 Methods and Results

For each participant in the ICG and ECG the mean energy consumption is calculated over all half hours for which they have data recorded, in Wh. Figure 34 shows the histogram of results for the ICG and the ECG. The peak of the external control group histogram (dark grey) is further to the left and narrower than the peak of the internal control group (light grey). The ECG has a much longer tail, with 22 participants having a mean higher than the highest mean in the ICG (approximately 405 Wh). The two data sets have similar means (147.4 Wh for the ICG and 151.5 for the ECG) but clearly, looking across the whole distribution they are different.



³⁰ Reducing the requirement that 98% of data must be available from 98% to 90% did not significantly increase the sample size, and so the high requirement was kept.

Figure 34. Distributions of mean half hourly electricity consumption for the Internal and External Control Groups.

Splitting the external control group into the five climate regions defined in Appendix A and compare the distribution of means in the ICG with the equivalent distribution for each regional group. Table 10 explains the five regional groups and the number of participants in the ECG from each region. The initial data provided by British Gas was screened for zero and negative values resulting in the cleaned sample size indicated.

Table 10: Number of participants in external control groups

Region	Areas Included	Sample Size
1	East England, London, South East England, South West England	378
2	East Midlands, West Midlands	377
3	North West England, North Wales, Merseyside, Cheshire, South Wales	475
4	Yorkshire, North East England	377
5	South Scotland	219

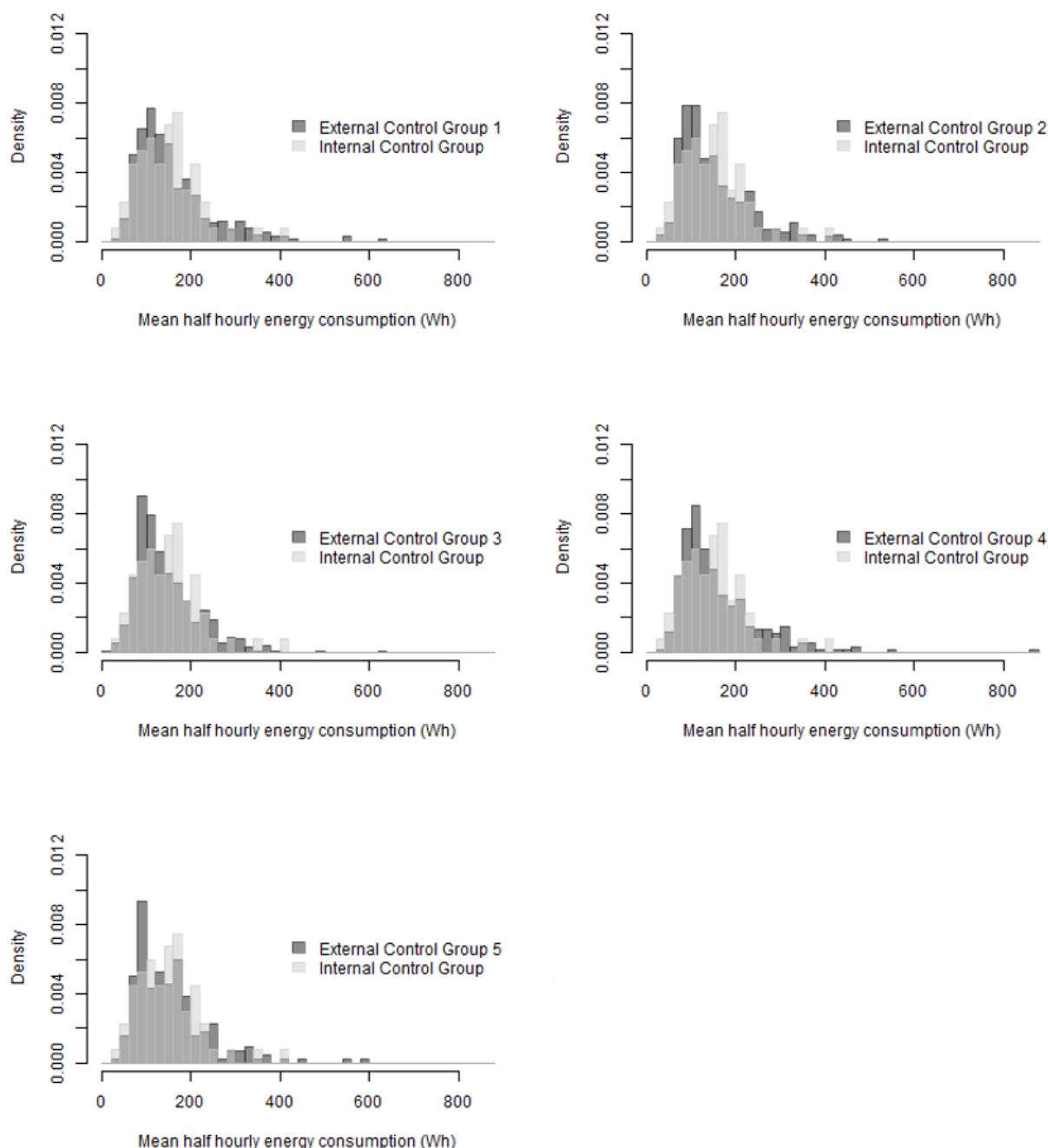


Figure 35. Regional breakdown of ICG and ECG consumption.

The distribution representing East England, London, South East England, South West England (ECG 1) is the most similar to the distribution of those in the Tower Hamlets area. This is to be expected since the Tower Hamlets study region belongs to this region. This provides reassurance that those in the **energywise** trial are most closely matched to those in the region from which they are drawn and the region most representative of the UK Power Networks distribution areas. It should be noted however that all regional groups have their peak at a lower mean half hourly energy consumption value than the ICG.

One way to compare distributions is to use a relative density method, such as those proposed by "Relative Distribution Methods in the Social Sciences" by Mark S. Handcock and Martina Morris. The 'reldist' R package and function of the same name were used to compare the relative distributions of all of the data points (not just the means) in the ICG and in the ECG. The dashed line shows what the results would look like if the two distributions were identical³¹. It can be seen that for low values of energy consumption (low ECG proportion) the ICG distribution is relatively less dense than the ECG (below the dashed line). This is also true for the highest values (on the right). The ICG distribution is higher (above the dashed line) between 0.3 and 0.9. This aligns with the results for the distributions of means, for which the ICG had fewer mean values at the lower end of the scale.

These analyses show that the distribution of energy consumption of the ICG and ECG are noticeably different, and therefore the internal control group is not representative of the external control group taken as a whole in terms of energy consumption. This, in and of itself, is not surprising given the known regional drivers of variance in electricity demand across the UK.

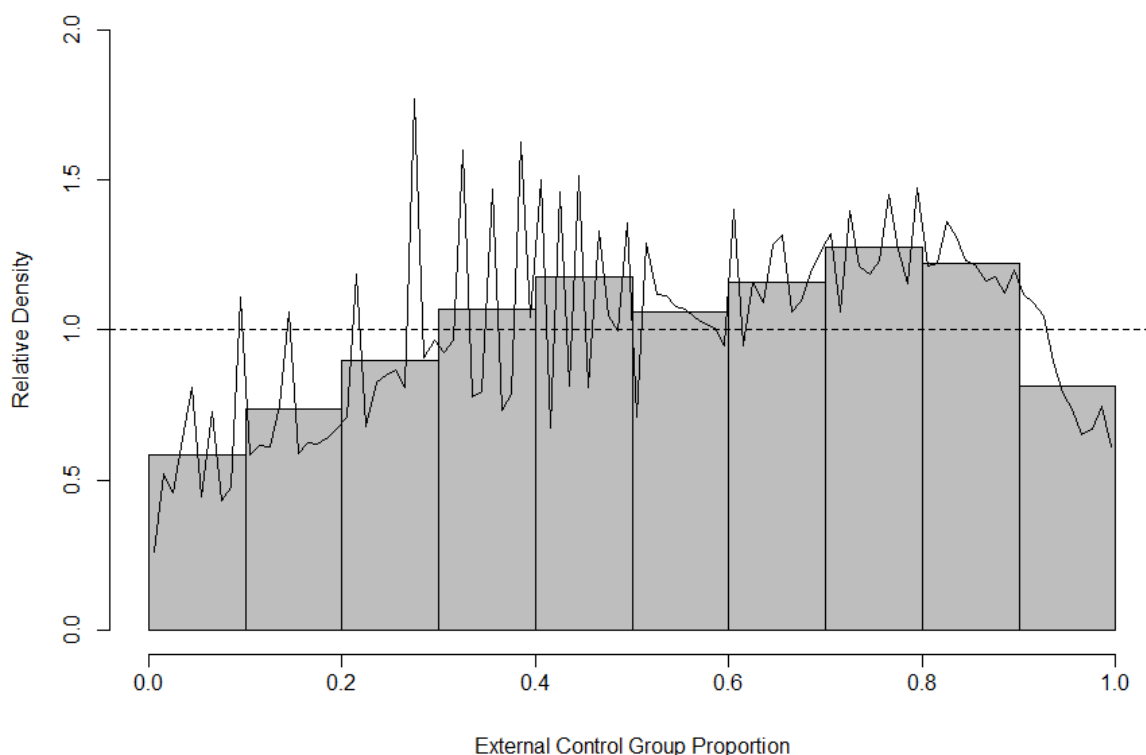


Figure 36. Relative density plot showing the difference between the ICG and ECG distributions.

It has been shown that the **energywise** participants use more energy than other households recruited into the ECG. It is important to note that while the criteria for recruitment into the ECG were on the most similar available basis to those recruited into the **energywise** trial, these criteria only explain a comparatively small proportion of observed variance in energy consumption – thus there remains substantial capacity for unobserved factors to account for variance in energy consumption between regions. The most probable explanatory factor for the different shapes of the distributions is differences in household size. It is known that household size is a (comparatively) strong driver of energy demand, and that the participants in the **energywise** trial in Tower Hamlets had atypically large household sizes.

³¹ In essence, the dashed line can be thought of as a representation of the ECG distribution, with which the distribution of the ICG is compared.

Independent of this analysis is the question of whether household's capacity to respond to the interventions in Trial 2 (Bonus Time for those with pre-payment meters and HEFT for those with credit meters) is dependent on their overall level of energy consumption. To explore this, the relationship between both types of shifting (HEFT and Bonus Time) and mean electricity consumption was investigated within the intervention group (those on the HEFT and Bonus Time tariffs). This is shown in the scatter plots in Figure 37 and Figure 38. Importantly, no association was found between household consumption and the level of shifting.

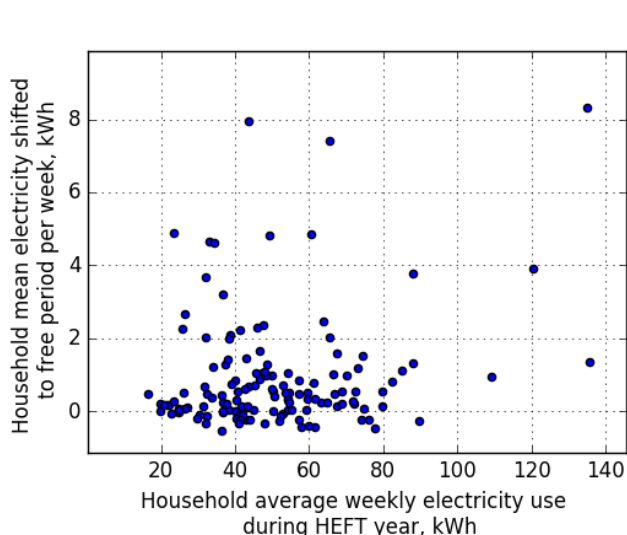


Figure 37: Home Energy Free Time participants' weekly consumption and shifting

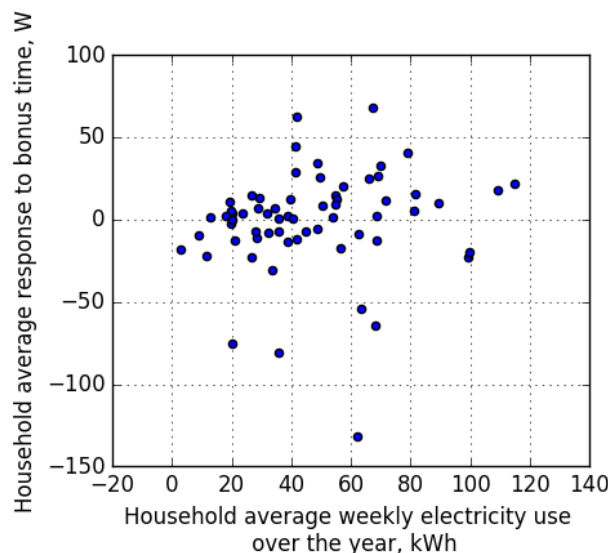


Figure 38: Bonus Time participants' weekly consumption and shifting

The evidence in the data from this trial therefore suggests that the amount households shift is largely independent of how much they consume. There is therefore no evidence supporting adjusting the anticipated level of shifting between regions based on their initial consumption levels. The factors explaining shifting (see Table 7 and Table 8 above) are the only factors identified through this trial that are correlated with energy shifting. Any generalisation of the findings from this trial to other network areas must therefore be based on the prevalence of these factors in households in other regions. The research design has identified these factors as mediating variables correlated with shifting, so it is reasonable to expect that their presence in other regions would similarly lead to shifting under these tariff designs. Given this, there is no basis for using any value other than what was observed in **energywise**, i.e. no net effect for Bonus Time, and 0.92 kWh for HEFT.

While comparison of the participants in the trial showed that their energy consumption was different from those in other areas of the UK recruited on the same basis, care has to be taken in concluding that the findings would not be observed elsewhere. There are two key elements governing the broader applicability of the findings, the first is how representative the sample is of the local population (effectively how much self-selection bias was in the sample), and the second is how representative the local population is of the wider population.

In the case of **energywise**, there are strong reasons to believe (due to the high response rate of 40% falling to 20% over the course of the trial) that the findings are a good reflection of the local population from which they are drawn. The findings from **energywise** are therefore likely to be substantially less biased by self-selection than those of most other trials in this field.

The local population, however, differs in its overall level of energy consumption from others recruited using similar metrics by British Gas. The external control group was based on the British Gas fuel-poverty indicator plus screening for presence of gas central heating and smart meter data back to 1 January 2016. Even though application of these selection criteria did not produce groups similar (in terms of energy consumption) to those in Tower Hamlets, this is not in and of itself evidence that others would not respond similarly to such interventions.

The local nature of the **energywise** trial, and all the benefits and learnings that entailed from the use of trusted local intermediaries and strong community engagement, inevitably risk local factors making the participants different from others around the country. At the start of the trial it was also assumed that metrics such as fuel poverty and vulnerability would themselves be determinants of consumers ability to save and shift energy, There is little evidence from **energywise** supporting this. This itself is encouraging.

5.5 Qualitative insights

The research has been designed to examine qualitatively how participants use energy. This has been carried out through three forms of data collection;

- i. observational notes recorded by CFOs with participants at their homes while carrying out the Home Energy Survey at the start of the Trial;
- ii. semi-structured interviews with 22 participants carried out by the social researcher at University College London, designed to get feedback on the project and Trial 2 experiences in particular; and
- iii. focus groups (participant panels) led by Bromley by Bow Centre with support from University College London and CAG consultants designed to get specific feedback on project communications and process as well as general feedback on experiences.

The Final Energy Saving Trial report³² discussed the qualitative insights relating to heating practices and thermal comfort; routines and appliance use; and feedback on project equipment. This report discusses insights on energy saving and shifting practices, using primarily the interview data, supplemented with insights from the focus groups.

5.5.1 Energy Saving

Participants' attitudes and behaviours towards energy saving during Trial 1 and 2 of the project can be summarised as fitting one of three modes;

1. those who feel that they were already energy conscious and the project has not had a big impact on their energy saving habits;
2. those that feel the project has helped them understand more about electricity use in their homes and are actively taking steps to save; and
3. those that feel confused about how electricity is used at home and how they can or are making savings.

Already energy conscious

Some participants feel that they are in general fairly aware of energy use in their home and try to reduce it. Some feel that they do not consume much electricity, only what is necessary and they do not consider their household as wasteful and therefore cannot identify areas for extra savings. A few described their energy savings as switching off lights when not in the room. This suggests that the project, despite high levels of support and information had not managed to broaden some participants' understanding of electricity consumption in the home either through the project equipment (e.g. the standby saver) or the smart meter equipment and IHD to learn more about what are more electricity intense activities and appliances. However, the project has targeted low income households who may be low energy consumers and therefore may have less opportunities to save.

Discovering new ways to save energy

For others, the project has provided an opportunity to discover new ways to save energy. This has been particularly evident in the discussions held by participants at the focus groups (participant panels). These quarterly meetings have provided opportunities for participants to share experiences and ideas around saving energy, and share experiences of using the project equipment to achieve savings. The three interviewees who had also attended panels described the panels as fulfilling this function; an opportunity to learn and apply this learning at

³² "The Final Energy Saving Trial Report", **energywise**, 2017, available from:
<http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Energywise/Project-Documents/energywise+Final+Energy+Saving+Trial+report+v1.6+PXM+2017-05-24.pdf>

home. This group found the shifting information leaflet produced for Trial 2 particularly helpful and liked being able to compare the energy intensity of different kinds of chores based on appliance use.

Outside this engaged group of participants, three other interviewees also said they had learnt new ways to save energy during the project. Two discussed using the In-Home Display (IHD) to check consumption levels of different appliances. For one customer this increased not only their knowledge, but also helped keep the issue salient. They explained that the IHD helps “[you] visually see when you’re using too much electricity”. Two found the kettle useful to identify savings. Another customer explained “before I didn’t really know about less water in the kettle would be spend[ing] less electricity”. For another it was turning off electronics rather than leaving them on standby. They explained “I learn stuff and I’m saving energy, I’m not wasting energy. Otherwise if I didn’t know about **energywise**, I would be wasting energy for no reason. So that’s a good thing”. One interviewee mentioned the energy shifting leaflet, explaining that they had found it useful to have “a breakdown of how much each appliance costs”.

Confused about saving energy

Five of the interviewees expressed some confusion about the energy savings they could or had made. For example, two said they wanted to reduce their energy consumption, but were not able to find any areas to cut back on. One participant found the IHD both “interesting and confusing” explaining that previously they had not known how much energy they were using and now “the display’s in front of my eyes” which makes them feel they are using too much energy, but they can’t cut down. “No-one can help us, it’s us” he explained. The second participant expressed the same sentiment. They described watching the IHD indicate a jump in consumption, and when asked if this meant he tried to change this he replied ‘No, I don’t. [What] would I have to change?... do you know anything to get my bill down?’. This experience may be of particular relevance to low income and fuel poor households who may be low energy consumers with little excess to cut back on.

An alternative experience is seeing a reduction in bills without understanding why. For example a husband and wife discussed how their bill had gone down despite not making any changes to their appliance use. The husband explained “I think a Smart Meter is quite good, it’s reduced my bill a lot.” While also saying that his wife, who was in charge of managing the home had not changed anything, nor looked at the IHD “so I don’t know if that is helping or not, or we are using less electricity or gas.” This was similar for a participant, who explained that they were “not making much of a change, but she still sees that she is having to top up less and she’s saying sometimes she gets the vouchers as well, so that’s a nice, little surprise for her”. For another customer, there was less confusion or questioning, just a happy acceptance that the bill had appeared to go down during the project without them consciously changing behaviour.

For credit meter participants, it could be the shift to accurate billing that creates this confusion, and the change in tariff for those that opted in to HomeEnergy FreeTime (HEFT). It is less clear for PPM households, but as indicated above, participants may be associating the bonuses and vouchers they receive with reduced outlay on energy.

5.5.2 Energy shifting

The two sets of energy shifting offers designed for the trial require very different responses from participants; Bonus Time (a Critical Peak Rebate offer) asks prepayment meter households to reduce consumption during specific periods at comparatively short notice. The HEFT offer (a Time of Use tariff) invites credit meter households to use free electricity on a known day of the week, which could encourage shifting consumption from other times of the week, or it could mean simply increasing consumption on this day. Nonetheless, there are some commonalities across the two about households’ responses to these offers and their experiences of shifting their electricity consumption.

Ability and appetite for shifting

Nine of the eleven interviewees with credit meters had signed up to HEFT, one had opted not to, and one had dropped out before the start of Trial 2. Of these nine households that were on the HEFT tariff, five described actively looking for shifting opportunities, two were trying to take advantage of HEFT, but felt there was little to do as they did not consume much electricity and were not often home, two were not trying to shift. One had forgotten

they'd said yes, the other was not taking steps because the person who'd consented to the shifting trial had not communicated this to the person who was in charge of running the household and responsible for the shiftable consumption (such as laundry).

All eleven of the interviewees with prepayment meters had signed up to Bonus Time, but only one was actively trying to shift. Two were aware of the bonus time periods, but felt there was little that they could do either because their family's after school routine prevented it, or conversely because they did not use much electricity in the evenings. The others were not trying to shift. For three this was because the person who'd signed up to Bonus Time was not in charge of the household chores and did not see this activity as something that could or should be shifted. For two, their vulnerability status excluded them from being able to fully understand and engage with the offer. Another two had misunderstood the offer. One thought they should increase their consumption during the Bonus Time events, and the other thought gas was included³³. When clarified, this participant was still not very motivated to shift, saying she would try and cut down during bonus time periods, but wouldn't actively alter her routine.

The participants who came to the focus groups were more engaged. Ten different people came to one or more of the four panels discussing responses during Bonus Time events and these discussions primarily focused on steps taken to shift. There was a lot of peer exchange of knowledge and tips for strategies to respond. There was also acknowledgement that people's circumstances at home affected the household's ability to respond. In general the panellists felt that households with children had larger and more flexible electricity loads (such as laundry) which they may be able to shift, but also that one person households were able to completely control their consumption. Nonetheless, three stated they were not able to act, one due to a broken washing machine – this was seen as the only flexible load in the household, one due to their adult son not engaging in the project, while using more electricity during the evening peak, and one due to low electricity consumption. This panellist explained that he was on a very limited income and making cuts and savings everywhere. He had cut his electricity consumption as much as he could. His experience is insightful in that he did not see Bonus Time as an opportunity to earn money. No interviewees or panellists interpreted Bonus Time in this way, those that were active saw the credits as rewards for effort. Those active participants that made statements during interviews or focus groups were motivated predominantly by the idea of reducing their electricity use and by being disciplined. The credits were interpreted as rewarding this discipline.

Flexible loads

In line with CLNR³⁴, Low Carbon London³⁵ and other studies, participants found laundry the easiest load to shift. Seven interviewees mentioned shifting laundry. *"There's only two of us, so we just save it all up. Saturday comes, nine o'clock, in goes a bundle, so we've changed our habits now."* However one participant had thought they'd shift laundry, but then forgot that they were on the HEFT tariff. Another was not seeing any impact in terms of bill reductions *"I can't see anything to change in the electric bill. [...] most laundry, I do on a Saturday, but the bill is the same, I don't know what's happened."*

Interviewees and panel attendees did identify other opportunities for shifting, for example one prepayment participant who has an electric oven mentioned rushing to cook dinner one Saturday, before a rare Saturday Bonus Time event would start. Bonus Time participants reported switching off lights and electronics, as well as avoiding hoovering, showering and hair drying. HEFT participants mentioned the charging of electronics, hoovering and the use of heaters during free periods.

³³ The team were concerned about participants misinterpreting the offer and sent out a text message to check if people understood correctly. Unfortunately only a very few people responded. The team also checked smart meter data to see if any households were consistently increasing their consumption during a Bonus Time period in a way that suggested they'd misinterpreted the offer. Furthermore all project communications including the SMS, newsletters and any personal contact, stressed that Bonus Time only related to electricity not gas.

³⁴ Bell, S. et al., 2015. Sociality and electricity in the United Kingdom: The influence of household dynamics on everyday consumption. *Energy Research and Social Science*, 9, pp.98–106.

³⁵ Carmichael, R. et al., 2014. Residential consumer attitudes to time-varying pricing (Report A2 for the "Low Carbon London" LCNF project), London.

Arbitraging between gas and electricity

Two households discussed using electric appliances over gas ones where they had that option. For example, one interviewee discussed using an electric cooker over his gas oven to bake on his free day, and a panel member discussed using her electric heater over her gas central heating on her free day to dry out a damp room. These activities can be interpreted as comfort taking rather than shifting, and were only discussed by HEFT households. As described, they show participants are aware of the potential to arbitrage in this way, however this would be a concern if participants continued to use more electricity outside the free hours, or after the end of the tariff. Using electric appliances over gas ones in this way would increase household energy costs.

Loads that can't be flexed

For the five interviewees that had electric ovens, cooking was not something easy to reschedule, due to family needs and habits. Only one discussed trying to shift cooking on the rare time there was a CPR event on a weekend. The others had not tried. As one explained *"She cooks her meals at the usual time. If it happens to go into Bonus Time, we're not going to turn the cooker off to save"*

Another sticking point, for Bonus Time households, was drinking a cup of tea. One participant explained *"there are some things that she won't give up, like if she wants to sit down and watch a bit of TV, she will do that. Five o'clock is usually the time when she drinks a cup of tea"*. Another also stated that *"there are things she can't really change, [...] if she wants a cup of tea in the evening, she'd still drink that cup of tea"*. However a panel member was determined that her husbands' peak time tea drinking was not going to undermine her household's response to Bonus Time. She filled up a thermos flask to enable him to drink hot drinks without boiling the kettle. Although this example demonstrates the creative ways that participants responded to these offers, it also raises a concern about distributional impacts. Making a cup of tea is not a comparable load to those more frequently studied in such trials (e.g. electric vehicle charging or air conditioning). It raises questions about the impact of asking low income households to take such steps to curb what may already be relatively low electricity consumption.

Other family members

Participants' experiences confirm what other research has identified that families with children have a particular schedule that makes certain activities hard to flex. This was particularly the case for Bonus Time participants who were frequently asked to avoid the evening peak. Although both panel members and interviewees did discuss successfully recruiting children in particular into their response strategies. In a couple of cases this related to college age or adult children who could be asked to carry out chores, in other cases this related to young children who could be excited about switching things off and monitoring the IHD.

Additionally, a new issue was raised by **energywise** participants; the split between the chore doer and DSR consentee. Across both HEFT and Bonus Time households, there were examples of the man in the household having signed up to the flexibility offer, but without communicating this to their wife (or in one case daughter-in-law) who ran the household. This meant the chore-doing continued according to the woman's schedule and was not flexed in response to the HEFT or Bonus Time offer.

The role of women in managing domestic labour

In a related point, when households were actively responding, women played a large role in delivering or co-ordinating household shifting. This was evident in both credit and prepayment households. This has distributional implications. According to the latest UK Time Use survey³⁶, women carry out the majority of domestic labour related to what are considered flexible loads (laundry, cleaning). An unintended consequence of offering flexibility products on the electricity market could be that women face an increase in the amount of domestic labour they perform, or they may find that they are not able to access the cheaper electricity or rewards these products can deliver. This is particularly the case in low-income households as they are less likely to be able to afford the home energy management systems or internet of things enabled appliances that aim to reduce the amount of labour and management tasks a household needs to do to make these flexibility products work and generate benefits

³⁶ UK Harmonised European Time Use Survey (HETUS), 2015

for the household. Furthermore, in some cases it may not be the women of the household who sign up to the tariffs, but nonetheless may find themselves responsible for making them work.

System gains

Three people mentioned that they felt they were contributing to system level gains.

One interviewee stated: *"We can change our habits, we can use energy in other periods of the day or week to save energy, help the country out and save more money at the same time, why not?"* One participant in a prepayment panel and one in a credit panel also expressed similar sentiments. They were not able to shift their consumption because, in the case of the prepayment panellist they had low electricity consumption, and in the case of the credit panellist, they were out of the house all weekend. Nonetheless, they discussed that their motivation to opt in was because of the potential to contribute to improving the electricity system. These two may have had a clearer understanding of the aims of the energy shifting trial because they were engaged in the panels.

Others discussed the inconvenience of avoiding evening peak, or of not having free time during a weekend.

5.5.3 Disconnection & Emergency credit use

Innovative learning outcomes: very little is known about why electricity pre-payment meter customers disconnect from their electricity supply. Any insights the trial can generate will help understand how smart meter pre-payment electricity meters impact on customers who self-disconnect.

1. Background and Rational for studying self-disconnection

Self-disconnection is "interruption to electricity or gas supply by consumers using prepayment meters [PPMs] because the card or key has not been charged and inserted into the meter"³⁷. Mummery & Reilly³⁷ go on to say that "an associated issue is 'self-rationing', where customers limit either energy use to save money, or restrict spend in other areas to ensure sufficient funds are available to keep the PPM topped-up" (p.7). For the purposes of this study, both self-disconnection and self-rationing are considered under the term 'self-disconnection'. Mummery and Reilly³⁷ give three reasons for self-disconnection, two of which are due to meter functionality ('Not realising the meter was low on credit' and 'forgetting to top the meter up in time'), while a third was not having sufficient funds.

One of the aims of the project is to understand why the participants were self-disconnecting. As Boardman & Darby³⁸ indicated, "along with the rise in prepayment meter usage has come a high incidence of self-disconnection: around a quarter of prepayment meter customers admitted going without an electricity supply at some time." Mummery & Reilly³⁷ found that half of the 718 PPM customers interviewed were self-rationing and one in six were self-disconnecting.

2. Method:

When designing the project, a reactive survey was considered, which could be sent to participants when they were identified as disconnecting. This was rejected due to difficulties with being able to immediately understand from meter readings if a participant is self-disconnecting. Instead, a diary was planned to be issued to each prepayment customer by a CFO during the data logger installation. This was not carried out due to the logistical difficulties of having an CFO in the property during installation and concerns that additional contact to deliver and explain the requirement to fill in a diary would lead to more drop outs, which at the start of the trial, was a large concern (given high numbers of participants leaving the trial at this time).

The approach taken was to generate qualitative data from three activities:

³⁷ Mummery, H., Reilly, H., 2010, "Self-disconnection among prepayment meter users". London.

³⁸ Boardman, B., Darby, S., 2000, "Effective Advice: energy efficiency and the disadvantaged", Energy and Environment programme. Oxford.

- Observational records (qualitative notes) documented by CFOs after they had carried out a home energy survey with a participant;
- Insights generated through the participant panel; and
- Semi-structured interviews with PPM participants, which included questions on topping up and disconnections. (The PPM participants interviewed were not participants who attended panels.)

3. Background on prepayment meter participants in the trials:

Installation: 127 participants, 61 Control and 66 Intervention (as of September 2015). Most intervention group smart PPM installations were carried out in October and November 2015. Control group PPM participants received their installations in early 2017.

Qualitative Notes: These record 50 entries in which people discussed metering and managing bills, of these 23 specifically mentioned PPM. None said they actively disconnected in order to manage their bills, but they did discuss going into emergency credit. Eight said they never use emergency credit, four said rarely, six said sometimes and five said they often do. Note that people may be self-rationing to avoid going into emergency credit.

In addition, one said they were having some trouble topping up with the new smart meter.

Smart vs standard meters.

- Same £5 emergency credit, but a different way to access it (In standard PPM emergency credit can be initiated automatically, or by inserting the key into the meter, for smart PPM it is initiated from the IHD)
- Both meters will beep when running out of credit, but the smart PPM will beep more frequently and users also get alarm symbol on the IHD. IHD will alert user when credit reaches a threshold. The user can set the threshold.
- Smart PPMs do not allow disconnection during 'non-disconnect periods' (e.g. Sundays & bank holidays).

4. Findings

Accessing Emergency Credit

Of the 11 interviewees, four discussed difficulties with accessing or using emergency credit on the smart meter/IHD in comparison to their previous dumb meter, which would automatically initiate emergency credit. For one this had caused an inadvertent disconnection in the night, two others had had to go immediately to top up and may have been off supply in this period.

"a week ago, in the morning when I woke up, I realised that none of the appliances were working and I noticed it was the credit that had gone low, so they topped up [...], when I had the old meter, the emergency credit of £5 would come in, but this one doesn't give me that option" (participant 12123)

In contrast, four find the IHD and smart meter help them keep on top of topping up, or find it generally convenient. One interviewee finds the beeping helpful in avoiding the use of emergency credit, another finds the IHD in general a convenient way to stay aware of how much credit is on there, and another finds topping up online helpful. A fourth liked not having to go to the meter to check credit. However none of these participants had ever self-disconnected, the smart systems facilitate their already capable management.

"when you had the meter on the wall, it would just beep when it's gone to emergency, it wouldn't give you a warning beforehand, so I wouldn't check it all the time, but because this is in my face and then it gives you a little alert beforehand, so you know to top up and no, I haven't been into emergency on that [smart PPM] one"

Three interviewees felt the IHD and smart meter had had no impact. For two, they never self-disconnect or use emergency credit. While the one participant who discussed occasional self-disconnection, the IHD had not made her more able to manage and avoid disconnecting. When asked if she found it made a difference, she answered

"No, I don't think it does, it's just one more meter to look at."

Disconnecting was something that happened because she found it hard to keep track of how much money she had on the meter. This participant's vulnerability status may affect her ability to manage their consumption. Other research has suggested that people with chaotic lives find it hard to manage and are the ones who self-disconnect³⁹, this participant's experience confirms that and shows that the smart functionality did not help her. Vulnerable people may not find smart energy displays any more easy or effective to use than standard displays on a PPM and may therefore not see any improvement in their ability to manage energy and avoid using emergency credit or self-disconnecting.

The participant panels support these insights into the process of adjusting to the new way of topping up. In a few cases participants had problems topping up or accessing emergency credit particularly at first. They discussed having to manually vend. One participant inadvertently disconnected from the electricity supply because the installation had been carried out when she was not at home and she had not realised she didn't know how to top up.

"I only found I didn't know what to do once the lights went out" (PPM participant at Panel 5).

A second participant discussed *disconnecting* from electricity supply because unaware of how to access emergency credit. A third discussed disconnecting from gas temporarily, but it was not clear if this was because of problems with accessing emergency credit.

Communications issues between the IHD, smart meter and vending process

Four of the 11 interviewees also raised issues of communications problems between the IHD and smart meter, and how this created difficulties with credit registering on their smart meter. All four discussed manually vending directly on their smart meter to overcome these issues. For one participant problems existed for the first few weeks and they reported manually vending at the start until the issues were fixed, but no problems since. For another two the issues are intermittent and ongoing. One has replaced his top up card twice since installation due to issues with reading credit. He now manually vends, but finds it 'a pain' to do because the number is very long, and his eyesight is not very good. The other has been told signalling issues in the area sometimes disrupt credit registering on her meter. There is a time lag, which on one occasion lasted two days. She now knows how to manually vend and add the credit to the smart meter. Before this, she once was off supply for four hours while waiting for her shop bought credit to arrive on her meter.

"There was a day, one of the team members came to carry out a survey here. I topped up at 12 o'clock, the credit didn't get registered, so I was without any electric, sitting in the dark, up until four o'clock [...] [A]t that time, I didn't know how to manually do it, so when someone turned up from the team, they called up British Gas for me and they asked how to manually enter it in"

A fourth participant reported their IHD had not been communicating with the meter for months. Although this had not led to problems topping up, it was nonetheless inconvenient to still have to read the meter to keep track of the credit.

"[The smart home display] hasn't been working for months. We've reported it six/seven times and they said that they'd try and fix it from their end, not to send an engineer out, but we've heard nothing. You can't get no readings, that's the only downside because the meter's nearly on the floor, the gas meter, you have to kneel down and try and see how much is on it, it's terrible"

This participant is elderly and struggles physically to kneel down to read the meter⁴⁰.

Again, discussions during the participant panels confirm these issues. In panel three, one participant mentioned manually vending to circumvent problems with the IHD, while another mentioned problems with their top up card not transferring the credit to the meter. In panel 6 three of the five attendees reported having to vend manually, and in panel 7 four of the five report manually vending.

³⁹ Mummery, H., Reilly, H., 2010, "Self-disconnection among prepayment meter users". London.

⁴⁰ The Field Officer team provided this participant with a direct number for the British Gas smart meter unit to get support.

The difficulties experienced by participants were raised with British Gas who worked collaboratively with the project partners to resolve customer concerns and re-visit understanding of the smart meter vend processes amongst prepayment customers. It is interesting to note that smart meter issues reported at customer panels (e.g. top-up concerns) were not always raised with British Gas by the customer directly. British Gas were keen to ensure equipment was working well for customers and sought to rectify issues as soon as they were reported. The British Gas smart programme is shaped by consumer feedback, who have researched over 200,000 customers to date with an aim to continually improve the customer experience of smart meters. 88% of British Gas Smart Pay As You Go customers surveyed agree their smart meters make it easier to top up with 90% agreeing smart meters help them understand their current balance and 8 out of 10 Smart Pay As You Go customers surveyed are more satisfied with their smart meters than their previous standard meters.

It is important to note that the smart meters for **energywise** participants were installed in the early days of the smart programme, during 2015. Smart prepayment services have developed since that time and we now have over 260,000 British Gas customers with Smart Pay As You Go meters benefitting from visibility of energy use, it's cost and remaining credit on their smart energy monitor plus more convenient ways to top up via online, over the phone, via smartphone app or still at a local pay point outlet.

5. Discussion

This qualitative data demonstrates two of the three reasons Mummery and Reilly⁴¹ have found for self-disconnection; not noticing that credit was low, and failing to top up in time. No one has mentioned a lack of funds as a reason for disconnecting. The research has not found evidence that the smart PPM and IHD has helped people avoid self-disconnection, although it has helped some people avoid going into emergency credit, and therefore helped them avoid using more costly electricity. Unfortunately, the transition to smart may have put some others at risk of self-disconnection due to problems with accessing emergency credit, or issues with credits appearing on the meter⁴². Some participants are used to the emergency credit automatically going on to the meter to keep the supply on, and are struggling to find out how to access emergency credit when they need it on a smart PPM.

These comments demonstrate some teething problems with customers not always knowing what to do, how to top up, how to access emergency credit. They also demonstrate some initial communication problems between the IHD and smart meters and registering credit. Six of the eleven interviewees had experienced either or both of these issues. Therefore suppliers, housing providers and organisations providing support services around energy and housing to vulnerable groups should be aware that some people may need additional support to avoid inadvertent disconnection when they move onto a smart PPM. This is particularly the case for partially sighted people who may struggle to manually vend. In addition, installers should perhaps clarify or reinforce instructions on how to vend manually as interviewees use this to avoid disconnection⁴³.

Although not experienced by any households interviewed, this raises a concern for visually impaired people who are unlikely to be able to manually vend themselves. The process depends on being able to read and input a vend code into the IHD or smart meter.

6. Summary

- There is a risk of self-disconnection when switching to smart PPM because of difficulties in accessing emergency credit or problems with credits arriving on the meter.
- People with chaotic lives or a vulnerability status that make it hard for them to manage electricity may not find the smart functionality and IHD helpful in improving their ability to manage.

⁴¹ Mummery, H., Reilly, H., 2010, "Self-disconnection among prepayment meter users". London.

⁴² The results of the qualitative research have been discussed with British Gas, and they have received the details of the specific customers who have been experiencing problems.

⁴³ British Gas report that their installation process and their information booklet both cover how to manually vend. Nonetheless all the households in the project received a British Gas installation for their smart PPM, but despite this a lack of understanding still appeared in interview and during the focus groups.

- People with more structured approaches to topping up can find the IHD and smart functionality helps them avoid using emergency credit.

5.5.4 Summary

- HEFT is an easier flexibility product for participants to understand and respond to. However some participants did misinterpret the offer, or reject it when they could have benefited from it.
- Bonus Time (non-punitive CPR offer) was harder for participants to understand and only one interviewee of the 11 interviewed was actively trying to respond, although most of the ten panel members were.
- Shifting experiences confirm some findings from other studies, in particular that laundry is easiest to shift and cooking is hard to shift. In addition some participants are creatively responding to the challenge, and some have been able to arbitrage between gas and electricity.
- The role of children is ambivalent; their school day schedules can limit shifting, but they can also participate in chore doing and checking appliances are switched off to support household shifting.
- The split between chore-doer and DSR consentee creates a barrier in household shifting. This could mean that non-punitive flexibility are less able to deliver network benefits as households opt in without expecting to shift or discuss with household members in charge of the household's flexible loads.
- There are two key distributional impacts to consider. First the appropriateness of encouraging low income households to reduce their consumption when they may have little to reduce. Second the impact on women who are tasked with most domestic labour.
- For low income households the main use of electricity in the home was for domestic chores, such as cooking, cleaning and laundry. These activities are not considered wasteful or as having substitutes, in the same way that air-conditioning for example. As Strengers explains, Critical Peak Programmes "can shift the meaning of air-conditioned cooling from a necessary to a wasteful activity, and encourage the resurrection of a range of alternative cooling practices that don't involve the use of this device."⁴⁴ This may not be achieved domestic chores such as cooking, cleaning and laundering, which may be harder for households to reinterpret as wasteful, given their association with health and hygiene, rather than comfort.

Key findings – quantitative analysis and generalisation

- The Bonus Time tariff conducted with pre-payment customers found associations between the presence of high power appliances such as electric cookers and tumble dryers and the level of shifting observed in homes. There was also an association between the presence of adults aged over 65 and shifting. This suggests that both the presence of flexible loads, and the presence of those with the time-flexibility to shift them is needed for response to occur. The presence of children or the overall number of occupants were not factors, nor were knowledge or the motivational factors measured. No statistically significant shift in energy was observed for Bonus Time.
- The HomeEnergy FreeTime (HEFT) tariff conducted with credit customers found associations between presence of how power appliances such as secondary electrical heating and tumble dryers and the level of shifting observed in homes. There was also an association between the presence of adults aged over 65, and a strong association with the number of occupants. The presence of children or the presence of an electric cooker were not factors, nor were knowledge or the motivational factors measured. A statistically significant response of 0.92 kWh per week per customer was observed, for shifting from the paid to the free period.
- Generalisation of **energywise** participants findings is challenging. The participants were found to have substantially different energy consumption patterns overall from others in an external control group of similar customers selected across Great Britain. From a purely statistical perspective, this makes inferring the behaviour of others difficult, as it appears energy consumption per-say is not a strong indicator of capacity to respond as initially assumed. The findings suggest that factors such as income, or energy use, are secondary factors in deciding who will respond to tariffs, and similar responses are more likely to come from those with

⁴⁴ Strengers, Y., 2013. Smart Energy Technologies in Everyday Life, London: Palgrave Macmillan UK.

large flexible loads and the time to reschedule household routines. These factors are distributed differently to income and energy use across the population.

6 Network insights

6.1 Network modelling

6.1.1 An introduction to the Element Energy Load Growth model

To model future loads across its three licence areas, UK Power Networks makes use of a load forecasting scenario tool developed by Element Energy that is specific to their network structure and is capable of forecasting load growth resolved to the level of individual distribution substations. The Element Energy Load Growth (EELG) model combines detailed data on the mix of domestic properties and business types, resolved to postcode sector level, with an accurate representation of the networks, in terms of the locations and connectivity of assets, in each licence area. This allows the load connected to each substation to be modelled on the basis of a highly resolved understanding of the customer mix. The EELG model also incorporates a comprehensive set of scenarios for future load growth, based on:

- Population and economic growth along with evolution of the building stock;
- Energy efficiency improvements in the domestic and commercial and industrial sectors;
- The uptake of a broad range of low carbon technologies such as electric vehicles, heat pumps (domestic and non-domestic), wind power, solar photovoltaics and domestic micro-generation; and
- The changing policy landscape and evolving consumer behaviours and appliance ownership patterns.

These scenarios are informed by a combination of historical trends, government projections and Element Energy's modelling of the uptake of energy efficiency measures and low carbon technologies⁴⁵. These models forecast the impact of differing assumptions regarding financial incentive regimes, technology costs, performance improvements and energy costs on the rate of uptake, based on a detailed understanding of consumer purchasing behaviour (informed by extensive consumer surveys). A simplified schematic of the EELG model is shown in Figure 39.

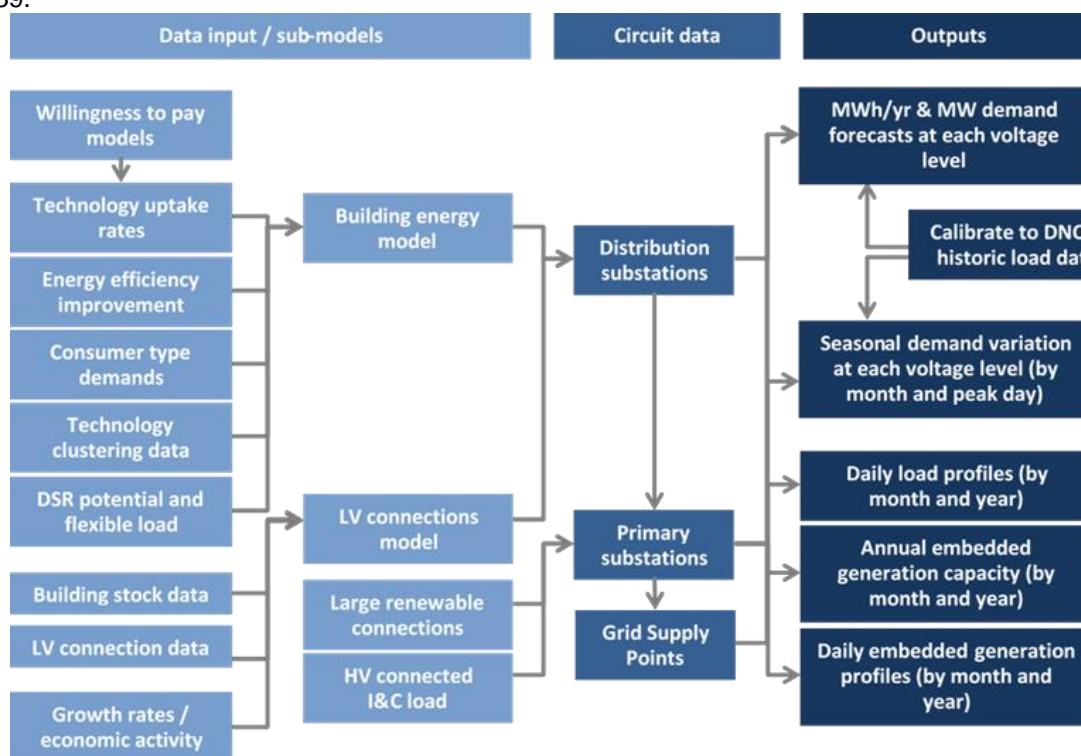


Figure 39: Simplified schematic of the EELG model.

⁴⁵ Developed in earlier work for the Committee on Climate Change, the Energy Technologies Institute and the Department for Transport.

The following are key outputs of the EELG model, which can be forecast for each substation and at each voltage level across the licence areas:

- Annual peak demand (MW);
- Total annual consumption (GWh);
- 24-hour demand profiles (MW) for a selected month and year; and
- Annual generation capacity connected (MW) for PV, wind and combined heat and power (CHP) along with their 24-hour generation profiles for each desired month and year.

Figure 40 shows two example output charts, which can be generated at different network levels, i.e. each of the UK Power Networks' licence areas, grid supply points, primary and secondary substations.

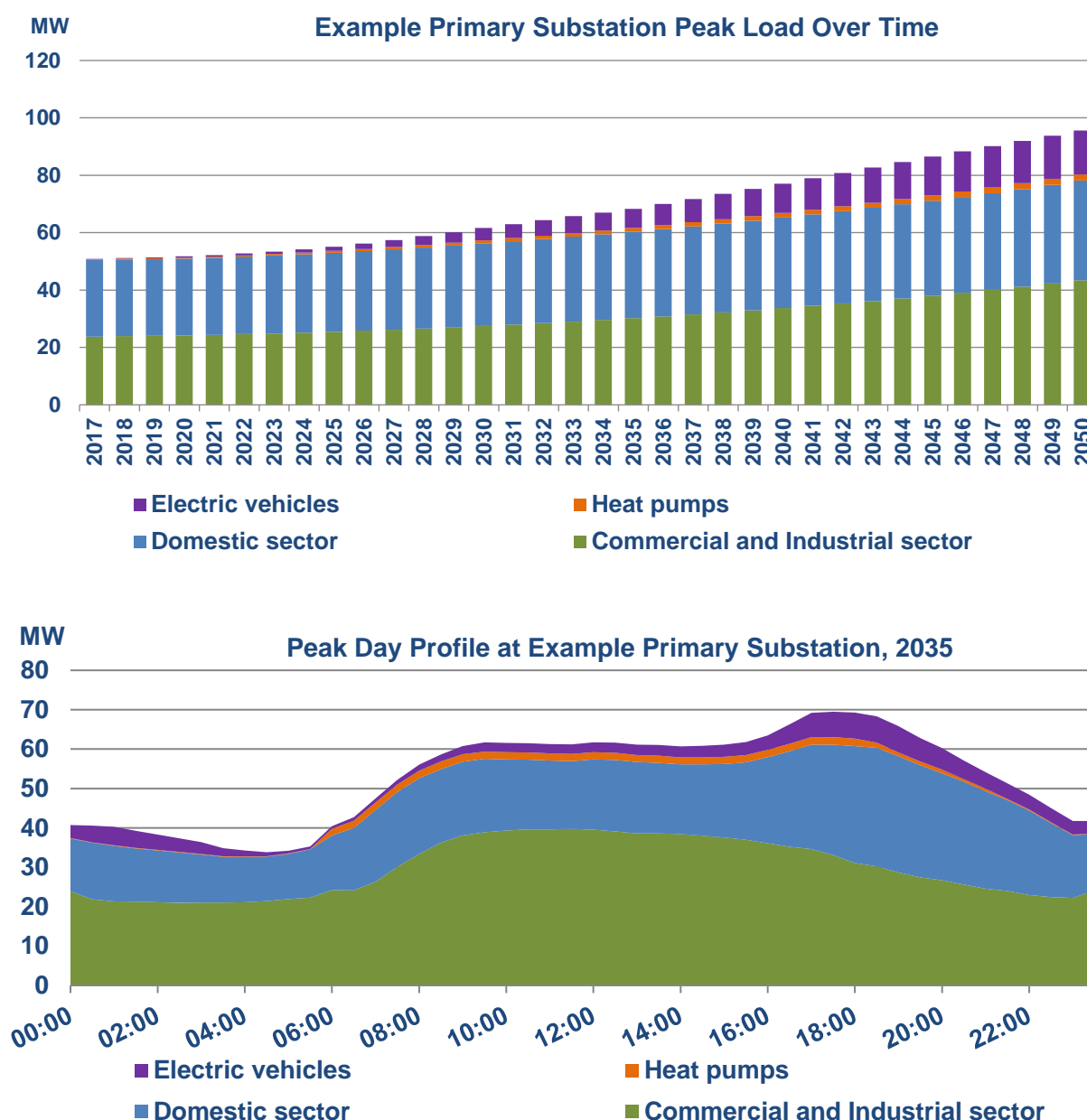


Figure 40: Example outputs from the EELG model. The top chart shows the evolution of peak load over time for an example primary substation. The bottom chart displays a typical load profile forecast for a specific future year at the example primary substation.

6.1.2 Updates to the EELG Model

The EELG model is regularly updated to incorporate new network, consumer and trial datasets as they become available as well as to account for changes in the economy, government policies and the cost and performance of various technologies. An important model update was carried out in 2015, as the datasets and learnings from various LCNF projects became available. In particular, extensive smart meter data for 5,510 customers and appliance ownership data for 2,830 households in the London Power Networks plc licence area were obtained from the LCL trial and integrated into the EELG model. Load profile datasets for various low carbon technologies and use cases were also obtained from LCL and the CLNR project.

Using these datasets, the domestic sector components of the EELG model were modified to accommodate the load profile data of nine household archetypes defined in the LCL project (based on a 3x3 matrix of household size and income). The new domestic customer archetypes and appliance ownership characteristic also allow a more detailed breakdown of energy efficiency impacts and evolving appliance usage characteristics on the load profiles of each of these customer archetypes. Additionally, Element Energy has updated the load profiles of heat pumps and electric vehicles (EVs) with the latest technology monitoring data from LCL and CLNR.

For the current **energywise** project, the EELG model was further modified to also address fuel poor household archetypes in the domestic sector. In addition to the 3x3 household types defined during LCL, the model has now been expanded to be able to also consider 3x4 household types:

- Three occupancy levels: 1, 2 and 3+ person households; and
- Four affluence levels: affluent, comfortable, adverse and fuel poor.

The appliance ownership data obtained from the household surveys conducted in the **energywise** project is also applied to the appliance ownership characteristics of the fuel poor consumer archetypes in the EELG model (in the same way the LCL appliance ownership data is applied to the other household archetypes). Based on these additions to the EELG model, it is possible for UK Power Networks to integrate additional visibility and understanding of fuel poor customers, and how they respond to energy saving and demand shifting interventions, into its network planning processes where appropriate.

New functionalities are also regularly added to EELG model in response to the availability of new datasets, changing customer behaviour and network conditions. For example, the submodule of the EELG model that calculates the load from EVs has recently been fully redesigned under the Recharge the Future project⁴⁶ to better account for the diversity of EV use cases (including black cabs and private hire), vehicle types, charging behaviours, charging locations, charger types, smart charging and vehicle-to-grid activities.

6.2 Half-hourly network load profile data

An important objective of the **energywise** project is to understand how network loads are impacted by fuel poor customers and their engagement with energy efficiency and demand shifting interventions. As part of the analysis in this chapter, the average load profiles of **energywise** trial participants are compared with the network load at the secondary and primary substations that the trial participants are connected to. Primary and secondary substations are key nodes on the electricity distribution network at which network voltages are transformed. Within UK Power Networks' London Power Networks (LPN) licence area, there are over 230 primary substations, which connect to around 18,000 secondary substations, which in turn connect (via feeders) to various end-users (e.g. households and businesses) served by the network. Of the primary and secondary substations within LPN, this project deals only with those connected, via the network hierarchy, to the participants on this trial.

6.2.1 An introduction to the half-hourly network data

UK Power Networks identified all the secondary and primary substations the originally recruited **energywise** participants were connected to using the MPAN associated with each household. 111 secondary substations were identified within the trial area associated with all the 538 recruited households, which are connected to seven

⁴⁶ Further information on the Recharge the Future project is available on the Energy Networks Association portal, available from: http://www.smarternetworks.org/project/nia_ukpn0028

different primary substations. Screening out any customer drop-outs registered by the end of Trial 2, active Trial 2 participants were connected to 60 secondary substations out of the 111 identified secondary substations that are transferring data through a Remote Terminal Unit (RTU). All 60 secondary substation datasets have been used in the following analysis. All seven primary substations are monitored by UK Power Networks via the installed RTU and have also been included in the analysis below. Half-hourly load data has been extracted from all monitored secondary (kW) and primary substations (MW) from May 2015 onwards and both datasets have been transferred to Element Energy to perform the network modelling.

6.2.2 Secondary substations

For the **energywise** energy shifting trial, UK Power Networks is monitoring all 60 secondary substations associated with the trial. Figure 41 shows the average diurnal load of these secondary substations over the full time period of Trial 2 (April 2017 to March 2018).

There is considerable variation in the average diurnal profiles of each secondary substation shown in Figure 41 due to the unique mix of domestic and non-domestic customers connected to each substation. However, the overarching trend across the secondary substations (as illustrated by the mean secondary substation profile shown in Figure 41) shows a distinct evening peak and a general profile shape that is broadly comparable to a typical domestic load profile. This is likely due to the high proportion of domestic customers (approximately 90% of customer connections) that are connected to the secondary substations associated with the **energywise** trial (i.e. these are secondary substations operating in predominately residential areas).

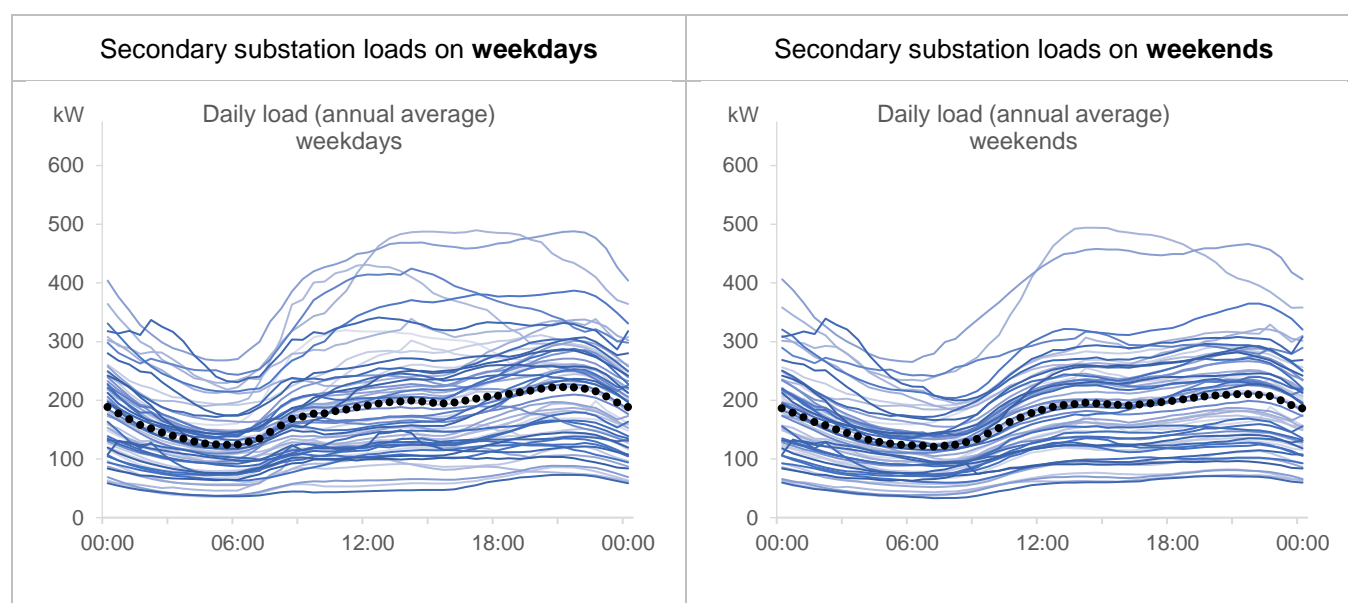


Figure 41: Average diurnal load profiles of the secondary substations associated with the energywise trial. Loads from 60 secondary substations are considered (monitored: April 2017-March 2018).

6.2.3 Primary substations

UK Power Networks is monitoring seven primary substations that are associated with **energywise** Trial 2. Figure 42 display the average load profiles of these seven substation over the same time period that was addressed by the half-hourly monitoring of **energywise** Trial 2.

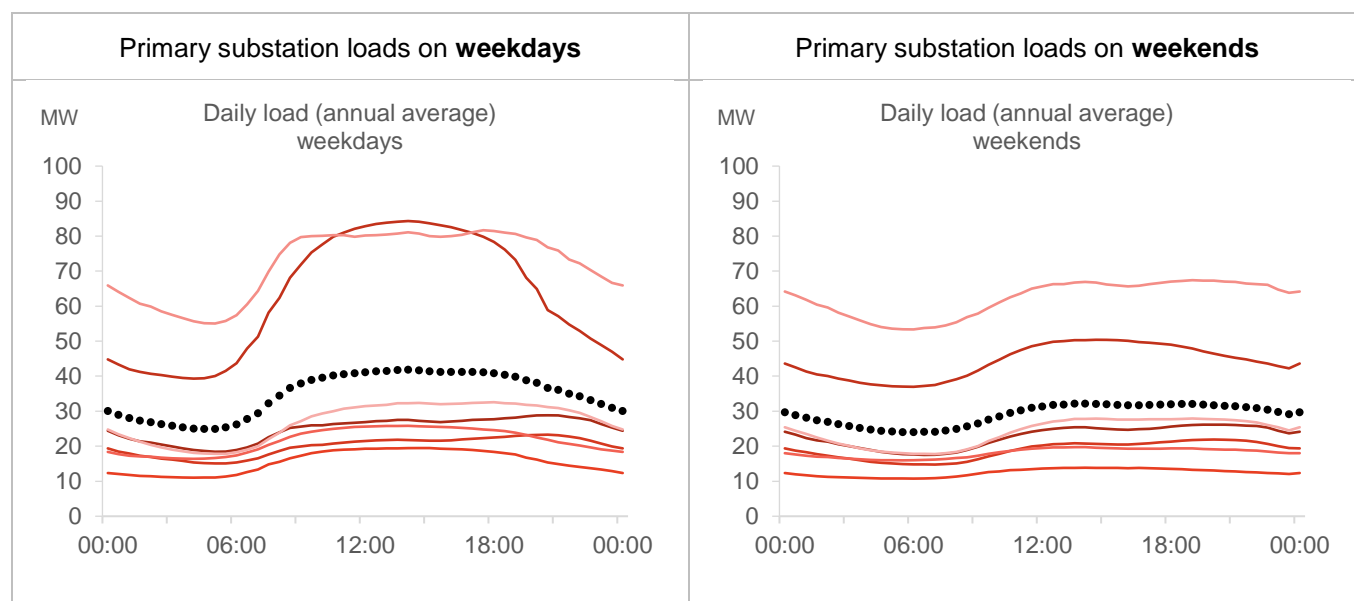


Figure 42: Average diurnal load profiles of primary substations associated with the energywise trial (monitored: April 2017-March 2018).

As can be seen in Figure 42, the mean profile shape for the seven primary substations exhibits a much flatter load profile (without a particularly distinctive evening peak) than observed for the secondary substations. This reflects the larger proportion of commercial and industrial loads represented at these primary substations. In keeping with this, the average primary load between 09:00 and 19:30 is noticeably higher on weekdays.

6.3 Half-hourly household load profile trial data

6.3.1 The energywise Trial 2 half-hourly household load data

This chapter examines the network impacts observable in the half-hourly trial participant load data from the two different Demand Side Response (DSR) interventions that were trialled during Trial 2 (the energy shifting trial) of the **energywise** project: Bonus Time (prepayment meters) and HomeEnergy FreeTime (credit meters). To do this, the analysis in this chapter focuses on the impact of Bonus Time and HomeEnergy FreeTime on the peak demand of the households involved in this trial (i.e. the maximum demand observed on the average household load profiles). This is different to the analysis provided in Chapter 5 which is centred around the customer and any savings they made – hence the analysis in Chapter 5 was in terms of average consumption (Wh) shifted across the various time periods of interest.

The half-hourly smart meter data shown in this chapter covers the period from 1 April 2017 to 31 March 2018 of Trial 2. For consistency, this section considers the same participants whose data was used to establish the findings presented in Section 5.3 and the same data cleaning procedures were applied (see Section 5 for further details). For an analysis of the customer load profiles observed during Trial 1 of the **energywise** project, please refer to the Final Energy Saving Trial report⁴⁷. In this section, the load profiles of the **energywise** trial participants are also compared to the network load profiles at the primary and secondary substations connected with Trial 2 of the **energywise** project.

⁴⁷ "The Final Energy Saving Trial Report", **energywise**, 2017, available from: <http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Energywise/Project-Documents/energywise+Final+Energy+Saving+Trial+report+v1.6+PXM+2017-05-24.pdf>

6.3.2 Bonus Time

Of the different Bonus Time event timings tested in the Bonus Time trial, the most pertinent from a network peak loading perspective, and subsequently the most frequently repeated in this trial, were events targeted at the weekday evening peak. These event types were typically scheduled between 17:00 – 23:00 on weekday evenings and accounted for 52 events over the 12 month period of the trial⁴⁸. The analysis in this section will focus on these six hour weekday evening event types.

Figure 43 shows the average customer demand profile for Bonus Time customers on days when a Bonus Time event was triggered between 17:00 – 23:00 on a weekday evening. This is compared to the average customer demand profile for those same customers on baseline weekdays when no events were triggered. The normalised average weekday load profiles for the secondary substations and primary substations associated with the **energywise** trial are also shown for comparison.

It can be seen in Figure 43 that the peak demand of the monitored households during the Bonus Time events was reduced by an average of 1.5% relative to the non-event baseline days⁴⁹. There was no statistically significant change in average daily consumption for Bonus Time event days relative to non-event days. As discussed in Section 5.5.2, participant interview feedback indicates that some of the participating households misunderstood the Bonus Time offer and thought they were supposed to increase their demand, instead of decreasing it, during the Bonus Time events. It is not clear why this misunderstanding occurred since for each Bonus Time event, the customer notifications all clearly stated to “Use LESS electricity in this period to get credits” and to “REDUCE your electricity use in this period to earn credits”. The Bonus Time trial is the first time a Critical Peak Rebate offering has been tested in the UK, so it may be the lack of precedence for this kind of scheme in the UK that contributed to confusion among some customers. Further clarification in this area may be required in future deployments of Critical Peak Rebate schemes in the UK to ensure full customer understanding of the fundamental scheme principles which would be expected to increase the amount of peak demand reduction achieved.

It is worth noting that the load reduction effect of the Bonus Time event was concentrated primarily in the first half of the six hour event (17:00 – 20:00) with a reduced impact being observed for the second half of the six hour event period (20:00 – 23:00). A similar asymmetry was observed in the weekday evening peaks of the dynamic time-of-use tariff trial performed as part of the Low Carbon London project and is likely linked with reduced customer activity and capacity for demand reduction later in the evenings and early morning⁵⁰. The timing of the Bonus Time weekday evening events were such that, even with the limitations around the duration of demand reduction behaviour, the weekday evening events were able to effectively target the time of peak demand for the households involved in the Bonus Time trial (18:00 – 19:00).

While the average primary substation and secondary substation load profiles for this trial peaked slightly before and after the peak demand of the participant households, the flexible nature of the Bonus Time approach means that the length and timing of the Bonus Time events could be appropriately adjusted to target the specific peak time of the constrained asset involved in each case. Indeed, the Low Carbon London dynamic time-of-use tariff trial showed that the response capabilities of households to price-based demand reduction signals is highest between 07:30 and 22:00, which aligns well with the peak times relevant for the primary and secondary substations involved in the **energywise** trial.

⁴⁸ Other events were triggered during weekends and at different times of the day, but practical limitations around the total number of Bonus Time events that could be triggered during the 12 month trial period meant that the 6 hour weekday evening peak events needed to take precedence for building up an event sample size that was sufficient to produce statistically significant results for that event type.

⁴⁹ A t-test performed on the Bonus Time data revealed that the 1.5% peak demand reduction was statistically significant ($p = 0.025$) using the **energywise** threshold of 0.025. The **energywise** project has adopted a statistical significance threshold of 0.025, which is explained in earlier project reports and is in line with current guidance from the American statistical Association ‘The ASA’s statement on p-values: context, process, and purpose’ (Wasserstein and Lazar 2016) to evaluate appropriate statistical significance thresholds in the context of each study.

⁵⁰ J. Schofield, R. Carmichael, S. Tindemans, M. Woolf, M. Bilton, and G. Strbac, “Residential consumer responsiveness to time-varying pricing”, Report A3 for the “Low Carbon London” LCNF project: Imperial College London, 2014.

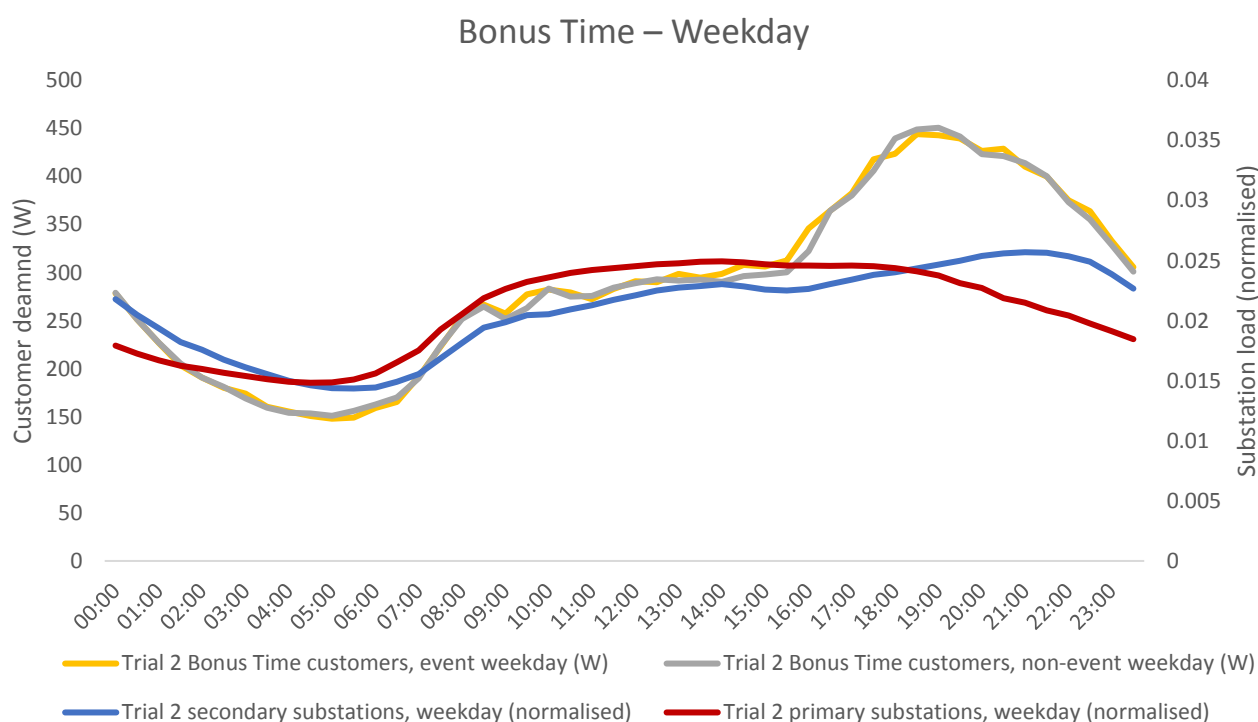


Figure 43: The average customer demand profiles for Bonus Time customers on Bonus Time weekday event days (yellow) versus weekday non-event baseline days (grey). The normalised average weekday load profiles for secondary substations (blue) and primary substations (red) are also shown for comparison. Data is averaged over the Trial 2 time period April 2017 to March 2018.

The 1.5% average reduction in the weekday evening peak observed during the six hour Bonus Time events is less than the 5% average peak demand reduction observed during the six hour high price events in the Low Carbon London dynamic time-of-use tariff trial⁵¹. It cannot be concluded from this whether the difference is related to the different customer demographics participating in these two trials, the way in which reductions were measured or the nature of the incentive schemes and their reward levels offered. International studies suggest that non-punitive Critical Peak Rebate offerings (like Bonus Time, which offer a reward for customers that reduce demand during critical peak events) are typically able to achieve peak reductions equivalent to (or in some cases more than) those of Critical Peak Pricing offerings (like dynamic time-of-use tariffs, which charge a higher price during critical peak events)^{52,53,54}. Further testing of the Bonus Time offering (or an alternative Critical Peak Rebate scheme) with a broader UK customer demographic (and potentially also exploring the impact of reward level) could provide further insight into this area.

As can be seen in Figure 44, the average demand reduction during Bonus Time events observed for each household varied considerably, with the best performing households achieving average demand reductions of 18.7%. This high level of demand reduction is consistent with the levels observed in other international trials (where average demand reductions as high as 21% were commonly observed^{55,56}).

⁵¹ Comparison was made to the demand reduction observed for the six hour Supply Following high price events in the Low Carbon London dynamic time-of-use tariff trial performed in 2013 which give the most relevant comparison for a six hour intervention without further price signals on either side of the event itself. See: J. Schofield, R. Carmichael, S. Tindemans, M. Woolf, M. Bilton, and G. Strbac, "Residential consumer responsiveness to time-varying pricing", Report A3 for the "Low Carbon London" LCNF project: Imperial College London, 2014.

⁵² "BGE's Smart Energy Pricing Pilot Summer 2008 Impact Evaluation", Baltimore Gas & Electric Company, 2009.

⁵³ "Ontario Energy Board Smart Price Pilot Final Report", IBM Global Business Services and eMeter Strategic Consulting, 2007.

⁵⁴ "CL&P's Plan-it Wise Program Summer Impact Evaluation", Connecticut Light & Power Company, 2009.

⁵⁵ "BGE's Smart Energy Pricing Pilot Summer 2008 Impact Evaluation", Baltimore Gas & Electric Company, 2009.

⁵⁶ "Ontario Energy Board Smart Price Pilot Final Report", IBM Global Business Services and eMeter Strategic Consulting, 2007.

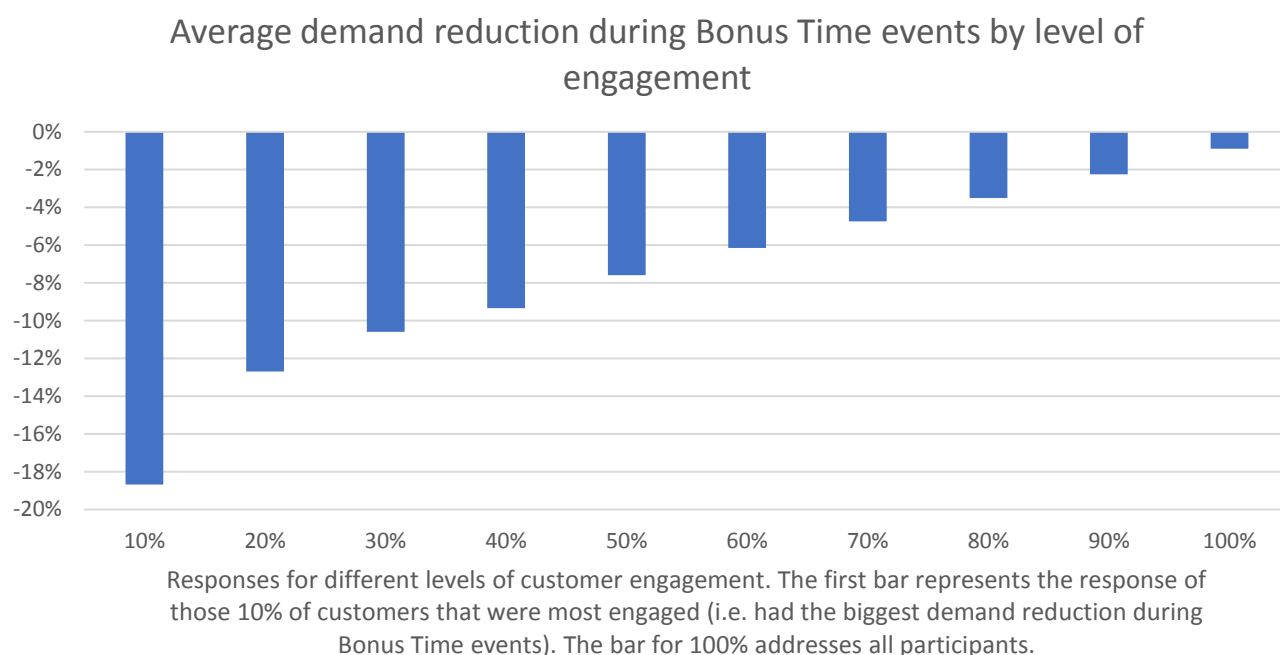


Figure 44: The average demand reduction for Bonus Time customers during Bonus Time weekday evening events by level of engagement.

The availability of sufficient flexible demand is an important aspect of customer response for Critical Peak Rebate schemes like Bonus Time. Indeed, it was shown in Section 5.3.1 that the presence of larger flexible appliance loads (such as tumble dryers and electric cookers) had a significant impact on the level of demand reduction that was achieved by households during Bonus Time events. Further testing of Critical Peak Rebate schemes (like Bonus Time) in the UK with a broader customer demographic will help to further quantify the importance of this factor.

6.3.3 HomeEnergy FreeTime (HEFT)

In the HEFT energy shifting analysis, the demand profiles for customers on the HEFT tariff are compared with their demand profiles in the previous year before they switched to the HEFT tariff. The analysis in this chapter reproduces the calibration of the previous year's data (to account for seasonal differences and other year-on-year effects between the two years of data that are unrelated to the trial intervention) as established in Section 5.3 of this report.

Figure 45 indicates that the **energywise** HEFT tariff was associated with an average 2.2% reduction in the weekday evening peak demand compared to that of the same customers before they switched to the HEFT tariff. This was combined with an average 22.2% increase in the peak demand observed for the weekend day containing the free period for customers on the HEFT tariff (see Figure 46)⁵⁷. The change in peak demand during the normal weekend day (i.e. the weekend day on which there was no free period) was negligible within the limitations of statistical significance (see Figure 47). There was also no statistically significant increase in average annual consumption for customers on the HEFT tariff relative to their consumption the year before, though it should be noted that it is not possible to disaggregate the effects of the HEFT tariff and year-on-year consumption changes due to other factors (such as seasonal differences, energy efficiency, changing appliance ownership, etc.).

⁵⁷ A t-test performed on the HEFT data revealed that the 2.2% reduction in the weekday evening peak demand ($p = 0.11$) and 22.2% increase in the weekend peak demand ($p = 0.005$) were both statistically significant using the **energywise** threshold of 0.25. The **energywise** project has adopted a statistical significance threshold of 0.25, which is explained in earlier project reports and is in line with current guidance from the American statistical Association 'The ASA's statement on p-values: context, process, and purpose' (Wasserstein and Lazar 2016) to evaluate appropriate statistical significance thresholds in the context of each study.

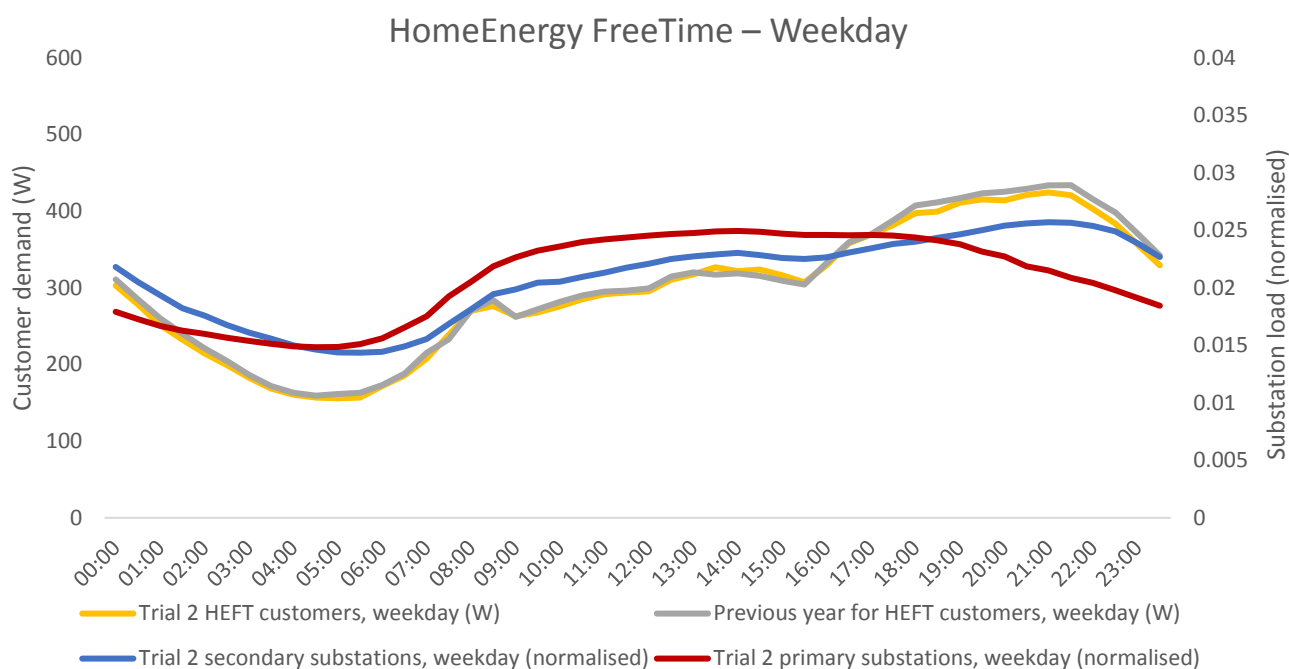


Figure 45: The average weekday customer demand profiles for HEFT customers during Trial 2 (yellow) versus their average weekday demand profiles from the previous year before joining the HEFT tariff (grey). The normalised average weekday load profiles for secondary substations (blue) and primary substations (red) are also show for comparison.

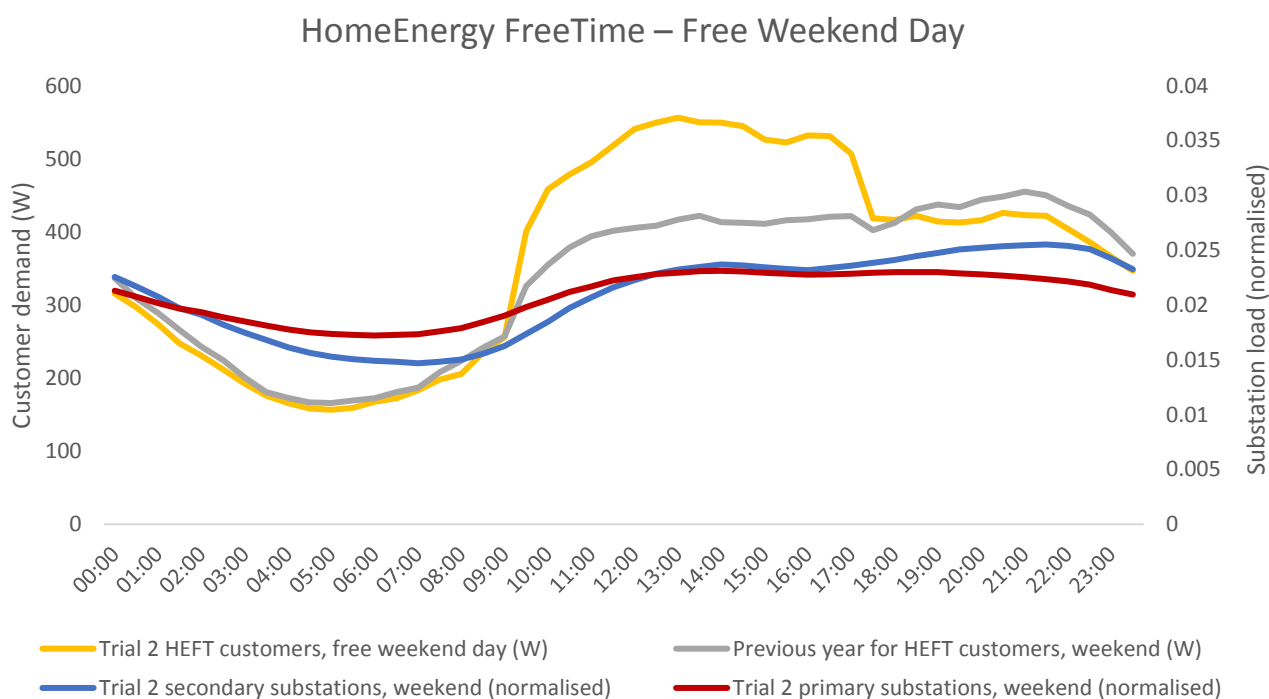


Figure 46: The average free weekend day customer demand profiles for HEFT customers during Trial 2 (yellow) versus their average weekend demand profiles from the previous year before joining the HEFT tariff (grey). The normalised average weekend load profiles for secondary substations (blue) and primary substations (red) are also show for comparison.

HomeEnergy FreeTime – Normal Weekend Day

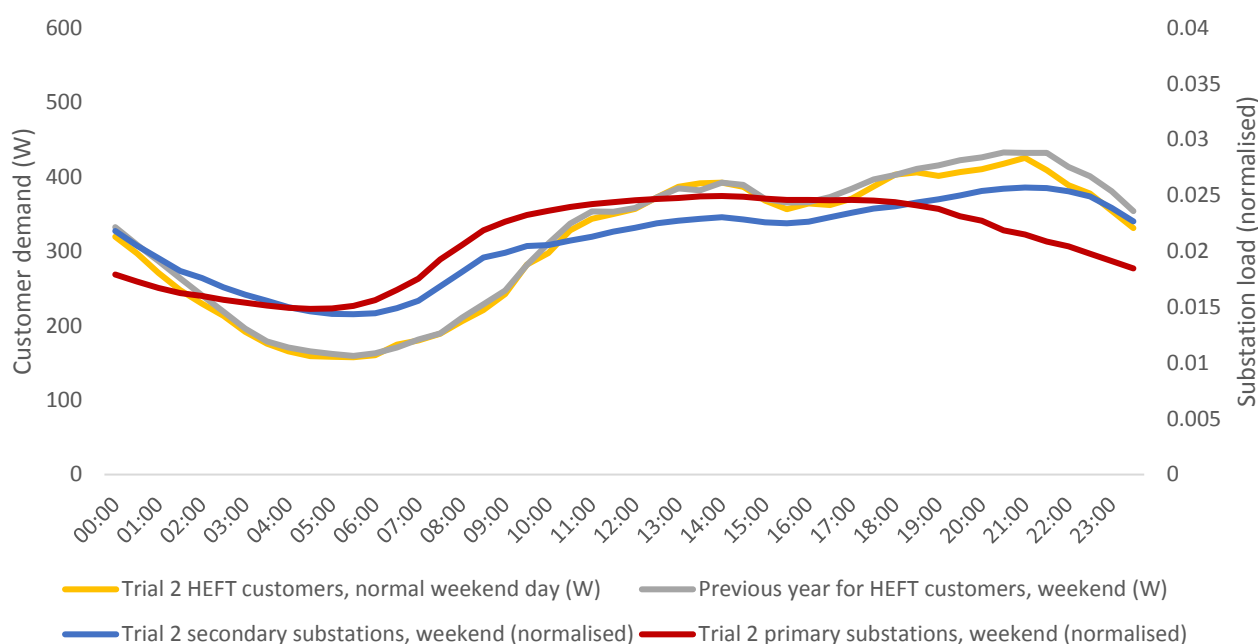


Figure 47: The average normal weekend day customer demand profiles for HEFT customers during Trial 2 (yellow) versus their average weekend demand profiles from the previous year before joining the HEFT tariff (grey). The normalised average weekend load profiles for secondary substations (blue) and primary substations (red) are also show for comparison.

To better understand the potential impacts of the increased weekend demand under the HEFT tariff, Figure 48 shows the potential impact on the peak demand of the secondary substations involved in the trial if all domestic customers connecting to each secondary substation were to take up the HEFT tariff⁵⁸. While the average 2.2% reduction in the weekday evening peak demand for customers on the HEFT tariff (see Figure 45) has the potential to slightly reduce the peak load for some of the substations shown in Figure 48, the average 22.2% increase in the weekend peak demand observed for customers on the HEFT tariff (see Figure 46) has the potential to create new larger weekend peak loads for many of the secondary substations from the trial under high levels of tariff adoption. The potential for the creation of new secondary substation peak loads that are significantly larger than current substation peak loads is an aspect of the HEFT tariff under high levels of uptake that will need to be carefully considered by distribution network operators if this type of tariff offering becomes more widespread among domestic customers.

While Figure 48 illustrates that the impact of the HEFT tariff on the peak loading of the secondary substations shown is potentially quite significant under high levels of tariff uptake, the impact on primary substations is less so (see Figure 49). In the case of the primary substations shown in Figure 49, there are high levels of industrial and commercial (I&C) loading that also contribute to the substation load profiles at this level. As a result, the weekday peak load at these primary substations is typically considerably higher than that of the weekend peak load (see Figure 42). Consequently, the formation of new primary substations peaks on the weekend due to the HEFT tariff would not be expected for any of the primary substations involved in Trial 2.

⁵⁸ The average domestic customer peak demand was taken from current Elexon Profile Class 1 and Profile Class 2 diurnal load profile data (available from: <https://www.elexon.co.uk/operations-settlement/profiling/>) combined with BEIS data on the proportion of Profile Class 1 and Profile Class 2 electricity meters among domestic customers in the Greater London Area (taken from the BEIS Domestic Electricity Middle Layer Super Output Area Look-up Tool). The assumption of 100% domestic customer uptake of the HEFT tariff was selected as an extreme case to illustrate the potential extent of network impacts and does not reflect current expectations around uptake levels of this tariff in the UK. The mix of customers choosing Saturday or Sunday for their free period was taken from the mix observed in the **energywise** trial (65% Saturday versus 35% Sunday).

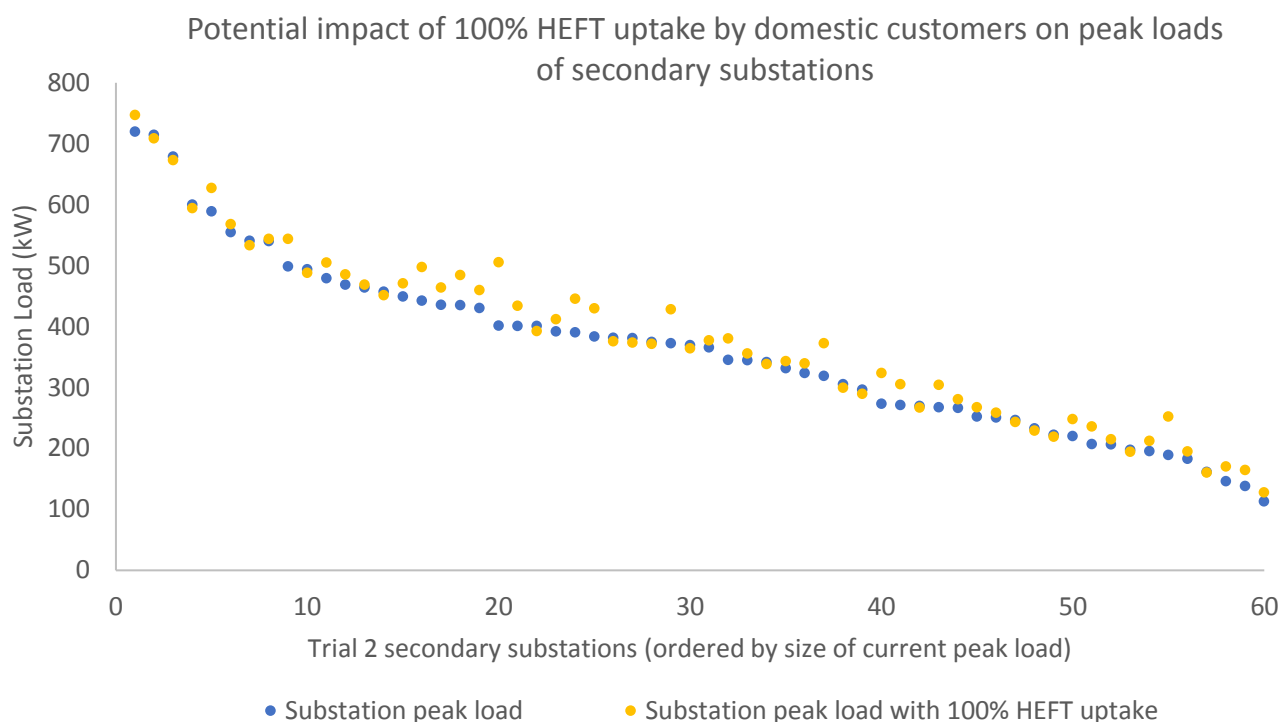


Figure 48: The annual peak load for secondary substations involved in energywise Trial 2 (blue) versus the new annual peak load that would be observed for each of these secondary substations if the HEFT tariff was adopted by all domestic customers connected to each substation (yellow).

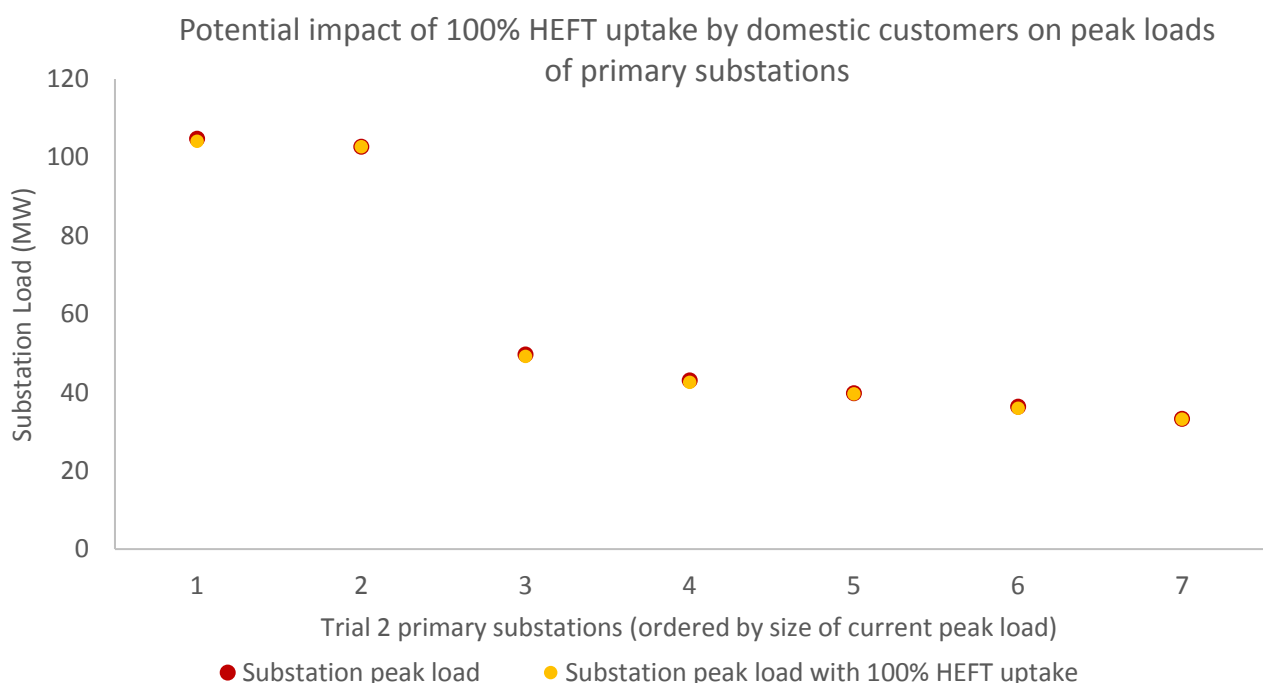


Figure 49: The annual peak load for primary substations involved in energywise Trial 2 (red) versus the new annual peak load that would be observed for each of these primary substations if the HEFT tariff was adopted by all domestic customers connected to each substation (yellow).

Key findings – network insights

Bonus Time

- The Bonus Time offering was associated with a 1.5% reduction in average weekday evening peak demand for all households involved in this trial.
- The level of reduction observed from different households varied considerably, with the best performing households (top 10%) achieving average demand reductions of 18.7% during Bonus Time events.
- Much of the Bonus Time demand reduction was concentrated in the first three hours of the six hour weekday evening events most frequently tested (17:00 – 23:00). This front-loading of demand reduction aligned well with the average peak demand period (18:00 – 19:00) of the Bonus Time participants and the flexible nature of the Bonus Time approach means that events could easily be tailored to the specific peak time of each network asset.

HEFT

- The HEFT tariff was associated with an average 2.2% reduction in the weekday evening peak demand of the monitored households.
- This tariff was also associated with an average 22.2% increase in the peak demand for the weekend day containing the HEFT free period. This has important implications for local network assets.
- At high HEFT tariff uptake levels, analysis found that many of the secondary substations involved could be subject to an increase in peak demand centred around a new substation peak during the HEFT free period. This impact was less severe for higher voltage level assets (e.g. primary substations) in which the impact is less apparent due to the contribution of industrial and commercial loads at these voltage levels.

Next steps

- This is the first time a Critical Peak Rebate scheme has been trialled in the UK and given the findings around the importance of the availability of large flexible loads, further testing of Critical Peak Rebate offers (such as Bonus Time) among broader customer demographics appears warranted, particularly those with flexibility around the use of high load electrical appliances.
- Further testing of different Critical Peak Rebate reward levels and structures to ascertain the price elasticity of peak demand reduction among domestic customers in the UK would also be valuable.

7 Comparison against technical potential

To obtain a sense of the scale of potential energy savings and demand shifting that could be achieved by the interventions in the **energywise** project, the technical potential of the main interventions in the **energywise** trials were estimated. This chapter compares how the latest technical potential estimates compare to the energy savings and demand shifting observed in the **energywise** trials as well as the potential network impacts if these interventions were rolled out more widely across the UK Power Networks licence areas.

7.1 Technical potential of energywise interventions

7.1.1 Intervention devices

The technical savings potential for each of the intervention devices provided to participants of the **energywise** project was estimated. These intervention devices included:

- Four light-emitting diode (LED) lightbulbs⁵⁹;
- An Eco-Kettle;
- A standby-saver device; and
- The provision of a smart meter and smart energy display (i.e. a real-time display).

An energy efficiency booklet and support advice were also provided as part of the interventions of **energywise**. However, the impact of these additional measures is not considered in this technical potential analysis⁶⁰.

The technical potential energy savings for each device were determined using appliance level load profile data from DECC and Defra's Household Electricity Usage Study⁶¹, household appliance ownership data obtained from the **energywise** Home Energy Survey, real-time display impacts on household consumption from the Energy Demand Research Project (EDRP) and appliance performance data from manufacturers. The estimated technical savings potential during the evening peak (i.e. maximum likely savings that could be realised during the evening peak if each appliance was used as intended) are shown in Figure 50 and are based on the following assumptions:

- Four existing lightbulbs (based on the average lightbulb ownership mix reported by **energywise** participants in the Home Energy Survey) are replaced with equivalent LED lightbulbs;
- The primary household kettle is replaced with a more efficient Eco-Kettle;
- The TV and periphery appliances to which the standby saver device is connected are typically in use during the evening peak time window. Therefore, it was assumed that the standby saver device does not contribute to peak demand savings for this analysis (though it is expected to contribute to overall annual household consumption savings); and
- The consumption savings associated with the provision of a real-time display (in addition to a smart meter or other half-hourly monitoring device) are in line with those observed in the Energy Demand Research Project trials for households with credit smart meters and prepayment smart meters⁶². The project has aggregated the savings levels observed for households with credit and prepayment smart meters using the relative proportion of these two groups within Trial 1 of the **energywise** project and applied the savings to the average annual load profile of the credit meter group of the **energywise** control group of Trial 1.

⁵⁹ Note that at the end of Trial 1, participants received a fourth LED light bulb. The fourth LED light bulb is introduced as an additional intervention in Trial 2 and has been included in the technical potential calculations.

⁶⁰ The Energy Demand Research Project trials found that there is considerable uncertainty around the impact of energy advice booklets and support advice, particularly in the context of how they interact with various accompanying interventions. Indeed, the advice booklet was reported to not significantly affect consumption in smart meter groups in the Energy Demand Research Project, though this may have been due to competing effects with other interventions: AECOM, "Energy Demand Research Project: Final Analysis", 2011.

⁶¹ J Palmer et al., Cambridge Architecture Research, Element Energy, University Loughborough, "Further Analysis of the Household Electricity Survey – Early Findings: Demand side management", 2013. Available from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/275483/early_findings_revised.pdf

⁶² The Energy Demand Research Project trial in 2011 reported that real-time displays (in addition to a smart meter) can provide further electricity consumption savings of 1.1% (for households with credit smart meters) and 0.4% (for households with prepayment smart meters): AECOM, "Energy Demand Research Project: Final Analysis", 2011.

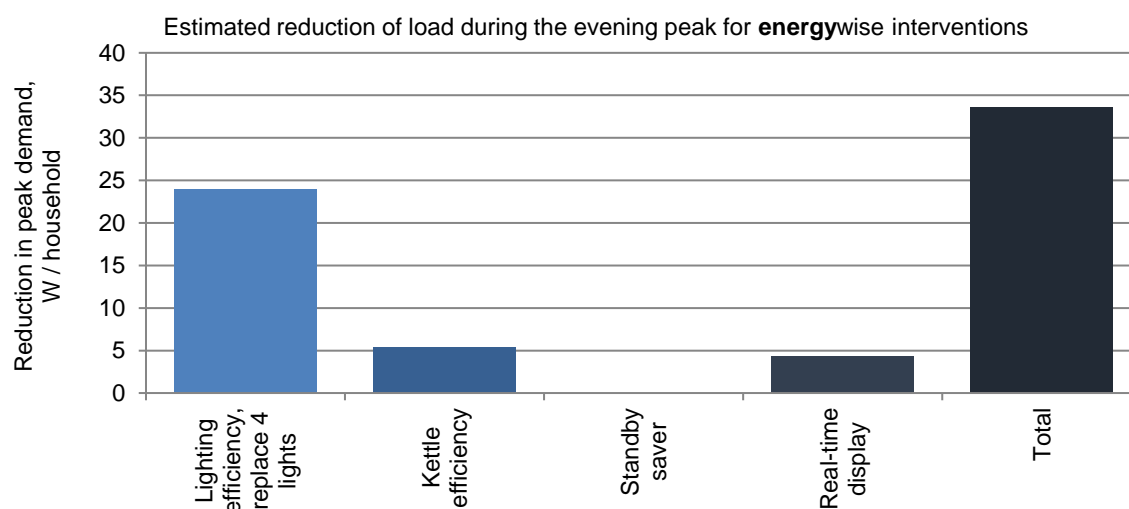


Figure 50: Estimated technical potentials for reductions in peak demand that are possible for the intervention devices provided by the energywise project (relative to the control group).

As can be seen in Figure 50, the total technical savings potential for the **energywise** Trial 1 interventions is approximately 34 W per household during the evening peak. This is an average peak saving over an entire year for a single household that makes use of all the devices provided (relative to the control group).

The actual average peak reduction realised in **energywise** Trial 1 (23 W) is smaller than the calculated technical potential for peak reduction (34 W). This is in part because only three LED bulbs were supplied in Trial 1 (whereas the technical potential is calculated for four LED bulbs since an additional LED bulb was supplied at the beginning of Trial 2) which accounts for approximately 6 W of this difference. The remaining 5 W difference is as expected as not all appliances were used by each household, and in some cases, they were used in a non-optimal manner (see the qualitative insights in Section 5.4). Therefore, the savings observed in the trial are promising relative to the calculated technical potential and reflect the capacity for meaningful engagement with energy savings in the trial participants.

7.1.2 Energy shifting

During Trial 2 of the **energywise** project, two different energy shifting interventions were trialled: Bonus Time (for prepayment customers) and HEFT (for credit customers). Given the substation specific complexities around the potential creation of new network peaks on the weekend under the HEFT tariff (see Section 6.3.3) and the limited data available in public literature on the impact of HEFT style tariffs, this section will focus on the technical potential of the Bonus Time offering.

The Bonus Time energy shifting offering is a type of Critical Peak Rebate (CPR) intervention in which customers are rewarded for reducing demand during critical peak periods. In the absence of any previous CPR trials in the UK, the potential impact of the Bonus Time offering was assessed using data from the Californian Save Power Day program (an extensive implementation of a CPR offering in the USA). Southern California Edison (SCE) offered the program to 206,000 residential customers in 2013. The program structure was similar to the Bonus Time offering that was trialled for **energywise** participants with a prepayment meter⁶³. Customers received a notification the day before an event and were encouraged to reduce consumption during a specific time window (14:00 – 18:00). SCE awarded the customer response by accrediting customers with a \$0.75/kWh rebate (which equates to roughly 5 kWh awarded for each kWh reduction).

The program observed an average reduction in customer demand of 4% during the CPR events. All CPR events that were triggered by SCE occurred in summer as the Save Power Day program is targeted at reducing air-

⁶³ 2013 Load Impact Evaluation of Southern California Edison's Peak Time Rebate Program, Nexant, 2014, available from: https://library.cee1.org/sites/default/files/library/12425/2013_SCE_PTR_Load_Impact_Evaluation_-_Final.pdf

conditioning load during summer. To best translate this finding into the context of UK domestic demand, the proportion of total Californian electricity demand that is due to air-conditioning (4% of annual consumption, based on U.S. Energy Information Administration data⁶⁴) was identified and the likely reduction in demand during a CPR event was discounted accordingly to account for the low incidence of air-conditioners among domestic customers in the UK. On this basis, it was estimated that the average potential for demand reduction across each Bonus Time event is approximately 1.6% of household demand.

The actual average evening peak reduction across all Bonus Time participants was 1.5% (see Section 6.3.2) which aligned well with the estimated peak demand reduction of 1.6% (based on the SCE CPR program in California). Adding in the technical potential impact of the **energywise** Bonus Time intervention to the potential peak demand impacts from the intervention devices (shown in Figure 50) gives the total technical potential peak demand impacts for the **energywise** interventions as shown below in Figure 51.

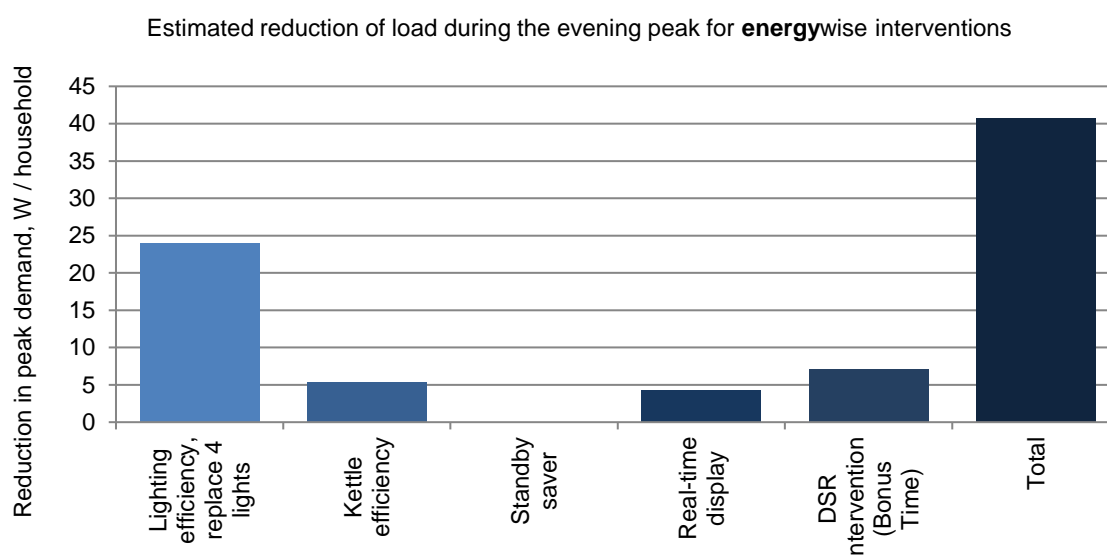


Figure 51: Estimated technical potentials for reductions in peak demand that are possible for the intervention devices and demand side response (Bonus Time) intervention in the energywise project (relative to the control group).

7.2 Potential network impacts if rolled out across UK Power Networks

The potential network impacts that could be achieved by rolling out the **energywise** energy efficiencies interventions (from Trial 1) along with the Bonus Time energy shifting intervention (from Trial 2) across all fuel poor customers in the UK Power Networks licence areas is estimated in this section. These estimates are based on scaling up the actual trial results observed in the **energywise** trials across all fuel poor customers in the three UK Power Networks licence areas. The calculations in this section make use of geospatially resolved data from the Department for Business, Energy & Industrial Strategy (BEIS) “Fuel poverty sub-regional statistics”⁶⁵ on the percentage of households classified as fuel poor to determine the number of fuel poor customers that are served by UK Power Networks (based on the Low Income High Cost classification). The relevant input data used in this report to estimate the number of fuel poor households across the UK Power Networks licence areas are based

⁶⁴ EIA, 2013, Household Energy Use in California, available from: https://www.eia.gov/consumption/residential/reports/2009/state_briefs/pdf/ca.pdf

⁶⁵ Department for Business, Energy & Industrial Strategy: “Fuel poverty sub-regional statistics”, available from <https://www.gov.uk/government/collections/fuel-poverty-sub-regional-statistics>. Data is provided at LSOA resolution (Lower Layer Super Output Area).

on the latest BEIS publications from 2017^{66,67}. It is worth noting that the estimated fraction of fuel poor households has increased in the 2017 BEIS report compared to previous publications, particularly for the UK Power Networks licence areas⁶⁸. Consequently, the peak demand reduction potential for fuel poor households has also increased relative to the view established in “The Final Energy Saving Trial Report” published at the end of **energywise** Trial 1⁶⁹.

Table 11 summarises the network impacts that could be achieved if the **energywise** Trial 1 energy savings and Trial 2 Bonus Time peak reductions⁷⁰ were realised by all households classified as fuel poor within the UK Power Networks licence areas. In total, an estimated annual reduction in electricity consumption of 86 GWh/year (equating to a total saving to customers of approximately £11.2m/year⁷¹) and a network peak reduction of 27 MW (equating to a potential deferred network reinforcement cost of between £2.7m and £5.4m) could be achieved across the three licence areas if the same interventions were provided to all households classified as fuel poor within the UK Power Networks licence areas.

Of course, these savings would need to be offset against the cost of customer engagement, devices, rewards and scheme administration associated with such wider scale interventions. For example, Bonus Time customers earned rebates ranging from £3 to £111 per year, with the average rebate comprising £37 per year. In this case, the deferred network reinforcement costs from Bonus Time would not be sufficient to justify the rebate costs associated with the scheme.

The cost efficacy of the provision of energy saving devices is dependent on the bulk purchase costs of the devices and scheme administration costs involved at scale. Based on the technical potential analysis in section 7.1.1, the provision of LED lightbulbs would be the most cost effective option (over the eco kettle and standby saver; smart meters and smart energy displays are already being rolled out in GB) for peak demand reduction. As the cost of LED lightbulbs continues to decrease, these may represent a cost-effective option in future in network constrained areas.

Table 11: Potential network impacts associated with the energywise interventions if rolled out across all fuel poor customers in the UK Power Networks licence areas.

Licence area	Number of fuel poor customers in licence area	Reduction in annual electricity consumption: Intervention devices	Reduction in network load during evening peak: Intervention devices	Reduction in network load during evening peak: Bonus Time	Reduction in network load during evening peak: Total
		GWh/year	MW	MW	MW
Eastern Power Networks	413,619	39	9.5	2.7	12.2
London Power Networks	248,684	23	5.7	1.7	7.4
South Eastern Power Networks	258,113	24	5.9	1.7	7.6
Total	920,416	86	21.1	6.1	27.2

⁶⁶ Department for Business, Energy & Industrial Strategy: “Sub-regional fuel poverty data 2017”, data available from <https://www.gov.uk/government/statistics/sub-regional-fuel-poverty-data-2017>

⁶⁷ Department for Business, Energy & Industrial Strategy: “Sub-regional fuel poverty data 2017”, report available from <https://www.gov.uk/government/statistics/sub-regional-fuel-poverty-2017>

⁶⁸ While the fraction of fuel poor households was previously reported at 8.2%-8.8% across the three licence areas in the 2014 BEIS data, the 2017 report from BEIS now indicates these values have increased to 12.3%-12.5%.

⁶⁹ “The Final Energy Saving Trial Report”, **energywise**, 2017.

⁷⁰ HomeEnergy FreeTime was not considered in this analysis because of the substation specific complexities around the potential creation of new network peaks on the weekend for this tariff.

⁷¹ Based on 13p/kWh.

Key findings – comparison against technical potential

Technical potentials

- The energy saving observed in Trial 1 from the energy saving devices provided to **energywise** participants (23 W peak demand reduction) compared well to that of the technical potential estimated from literature data (28 W when comparing on a like-for-like basis) reflecting the meaningful potential for engagement with energy saving devices among the fuel poor customers in this trial.
- The energy shifting observed in Trial 2 (1.5% average evening peak reduction across all Bonus Time participants) also aligned well with the technical potential estimate (1.6% based on a relevant large scale Critical Peak Rebate trial in the USA – appropriately scaled for the low incidence of domestic air-conditioners in the UK).

Potential network impacts

- If the **energywise** Trial 1 energy savings and Trial 2 Bonus Time energy shifting were realised by all households classified as fuel poor within the UK Power Networks licence areas, an estimated annual reduction in electricity consumption of 86 GWh/year (equating to a total saving to customers of approximately £11.2m/year⁷²) and a network peak reduction of 27 MW (equating to a potential deferred network reinforcement cost of between £2.7m and £5.4m) could be achieved across the three UK Power Networks licence areas.

⁷² Based on 13p/kWh.

8 Insights on customer protection

8.1 Introduction to customer protection strategy

Given the project's objective of involving vulnerable customers, it is important that protections are in place to ensure that the project follows the principle of 'do no harm' in terms of its participants.

The project's Communications Plan made the following commitments related to customer protection:

- Procedures for handling complaints and enquiries; systems are in place to ensure that any complaints or enquiries are dealt with promptly by the appropriate partners (Sections 8.1.2 and 8.1.3);
- Vulnerability; once participants consented, they were surveyed about their personal circumstances to provide the project with greater confidence about their suitability to take part in the project. The original intention was that customers who are blind or visually impaired will not be able to take part in the project, as there is at present no IHD suitable for these customers. Those who are most vulnerable to suffering as a result of short term power outages, i.e. those dependent on electrically operated medical equipment, would also not be eligible to take part in the trial. This is discussed in Section 8.1.2 below;
- Participant wellbeing; the temperature of customers' homes was monitored to ensure both that the project does not adversely affect participants as a group, and also to flag up any dangerously low temperatures in the homes of any participant. Further information on this is provided in Section 8.2;
- Work affecting participants' power supplies; where smart meters were installed, energy supply was turned off during installation for around 30 minutes. As anticipated, the project has not necessitated any interruptions to supply associated with work on the distribution system; and
- Safety; installations of all equipment complies with British Gas' Smart Meter Customer Charter and all relevant licence conditions. British Gas' Smart Energy Experts carry out risk assessments before starting any work at a customer's home and carry out safety checks as necessary. All equipment provided is CE marked.

This section focuses on the procedures that have been put in place to ensure participant wellbeing.

8.1.1 Handling complaints and enquiries

Since March 2016, Bromley by Bow Centre has maintained an electronic complaints and issues log, which records, by customer, any query or issue that arises, with information on the action taken, mitigation plan and progress status. Prior to March 2016, issues were passed directly onto project partners as required without being captured in a central log. It was recognised that this was not ideal which is why this central record has been put in place.

Since the start of April 2017, this log had issues recorded by just three customers (compared to 21 received between March 2016 and April 2017, as reported previously in the Final Energy Saving Report⁷³), as follows:

- A query relating to a Smart Energy Display which a customer reported to have stopped working. This was referred to British Gas and was resolved.
- Two queries about eco-kettles which customers reported were no longer working. One was replaced but the other query was received after the end of the trial, and it was explained to this customer that the eco-kettle was no longer under warranty.

⁷³ The Final Energy Saving Trial Report", **energywise**, 2017, available from:
<http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Energywise/Project-Documents/energywise+Final+Energy+Saving+Trial+report+v1.6+PXM+2017-05-24.pdf>

8.1.2 Vulnerability

In identifying customers eligible to be invited to take part in **energywise**, those known to the social housing associations and to British Gas to be most vulnerable to suffering detriment as a result of participation in the trial were removed from the list of eligible participants. These included:

- Those who are blind/visually impaired;
- Those in debt to British Gas; and
- Those who were highlighted as “seriously ill” or “confined to bed” were also excluded.

The project recognised that not all required information, particularly related to the vulnerability of households, would be readily available at the time of identifying and selecting the trial participants due to knowledge gaps. However, the project incorporated a customer-oriented approach and a team of CFOs were dedicated to the continuous engagement with the trial participants. Where the CFOs identified that a trial participant was more vulnerable than initially realised, they had the capability to assess their situation and make recommendation on the appropriate course of action. If someone was identified as ‘too vulnerable’ to participate in the project whilst having been enrolled in the project, the CFO would have made the recommendation to the project team on the condition of the customer and, if deemed suitable, the customer would have gone through a disengagement journey out from the project. No customer was identified to be too vulnerable to participate in the overall project, though one was found to be too vulnerable to participate in Trial 2, as detailed below.

Following recruitment, once trial participants had given consent to share their data within the project partners, the project performed additional checks on the vulnerability of each recruited household in order to ensure that their status as known by the project has not changed over time. Individual organisations such as the social housing providers, British Gas, UK Power Networks and Bromley by Bow Centre have provided any vulnerability status recorded in their databases associated to the recruited households.

Bromley by Bow Centre has acted as data aggregator and first reviewer classifying each household under one of the following categories:

- **Green** – lowest level of risk to customer related to involvement in trial (e.g. where the only vulnerability flag is that there is someone under 16 on the trial, or someone over 60, or where they have mobility issues or are hearing impaired);
- **Amber** – medium level of risk. This may include those categorised as 'mental health issues' or 'long term illness'. Some of these may be categorised as green based also on the CFOs' observations); and
- **Red** – high level of risk. Red would include anyone who is blind/visually impaired, dependent on electrically operated medical equipment, or where there is a concern that the customer could not have given informed consent due to learning difficulties or mental health issues.

The assessment, which included both the vulnerability flags provided by each organisation and the observations from the CFO team, identified eight households considered at high risk (**red**) and seven at medium risk (**amber**) out of those still participating in the trial.

As reported in the previous Final Energy Saving Report, the CFO team developed an anonymised spreadsheet that collates data held by project partners in relation to vulnerability for all participants. As previously reported, initially, 300 households with any indication of vulnerability were listed on this spreadsheet. Following the initial review, conducted in April and May 2016, it was agreed that all these participants could remain in the trial.

A revised vulnerability review was completed in May 2017. As reported previously (in the Final Energy Saving Report⁷⁴), this found that:

seven households were identified as high risk (i.e. blind/visually impaired, dependent on electrically operated equipment, or where there is a concern that the customer may not have given their informed consent due to learning difficulties or mental health issues), of whom:

⁷⁴ The Final Energy Saving Trial Report”, **energywise**, 2017, available from:
<http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Energywise/Project-Documents/energywise+Final+Energy+Saving+Trial+report+v1.6+PXM+2017-05-24.pdf>

- four were identified as high risk in the May 2016 review;
 - three were previously categorised as low or no risk (and have therefore not been discussed previously).
- seven were categorised as medium risk. This may include those categorised as 'mental health issues' or 'long term illness', of whom:
 - three were flagged as medium risk in the May 2016 review; and
 - four were previously flagged as low risk.

A meeting was held in June 2017 with relevant project partners to discuss the risk assessments and whether any action was necessary. At this meeting, the risk assessments were agreed and 13 participants were assessed as being medium or high risk in terms of vulnerability.

It was also agreed that risks from Trial 2 to participants are minimal as both the time of use tariffs are non-punitive. Two minor risks were identified:

- prepay customers who are blind or visually impaired (of which there are two) may not be able to read their Bonus Time notifications. However, all customers have consented to receiving Bonus Time notifications. It was agreed that Bromley by Bow Centre would check whether these customers had responded to the text message sent in May 2017 asking them to verify their understanding of how Bonus Time works. One had responded to confirm correct understanding and one had not; the customer ID for the latter was passed to University College London to enable them to monitor whether and how they are responding to Bonus Time. University College London has established that this customer earned a relatively high rebate in one month and a very small rebate in other months, potentially suggesting random rather than intentional responses. It was planned that University College London plan would interview this participant as part of the case study work to help more accurately gauge their understanding. However, this participant has indicated that she feels there is too much contact from the project and has asked not to be contacted unless absolutely necessary. Therefore it has been agreed that this participant is not contacted.
- there is a small risk that some customers may have misunderstood how the tariffs work. Of the 13 participants identified as being medium or high risk:
 - two said no to taking part in Trial 2 and therefore this does not pose an issue to them.
 - four said yes to receiving Bonus Time and all have received credits, two consistently above average, suggesting they have not misunderstood how the tariff works. (If they had misunderstood the tariff, then they would be trying to use more electricity during Bonus Time periods rather than less and would earn zero credits);
 - seven are credit customer who said yes to HEFT.

These 13 participants were monitored by University College London for any indication of misunderstanding; no such indication was found.

8.1.3 Disclosure Board

The disclosure board is an important project control mechanism in relation to customer protection, which provides an escalation route for the CFO team in relation to safeguarding items observed while interacting with the households and a mechanism for the project partners to obtain decisions on best course of action aiming to maximise the safety both to customers and the CFO team.

There have been no disclosure board cases since the early part of 2017. Details of previous disclosure boards can be found in the Final Energy Saving Report⁷⁵.

⁷⁵ The Final Energy Saving Trial Report", **energywise**, 2017, available from:
<http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Energywise/Project-Documents/energywise+Final+Energy+Saving+Trial+report+v1.6+PXM+2017-05-24.pdf>

Dependent on the seriousness of the case, the participant may be removed from the trial so that they can receive appropriate advice and support. No participant was identified 'too vulnerable' to take part in the project as part of the Disclosure Board process. Those leaving the project would receive a leaving pack including the Consumer Services Charter (Figure 52) providing advice and signposting to local and nationally available services relating to reducing energy costs. Where possible, it is also envisaged that they would be referred to other services as appropriate.

Learning

As a result of the learning from the operational phase of the project, the terms of reference of the Disclosure Board were reviewed by Bromley by Bow Centre. It was observed during the installation phase of the project that a faster and more direct escalation protocol may be required in specific circumstances (e.g. in case of technical matters). Also at the evaluation workshop in May 2016 partners agreed that the Disclosure Board was being used to consider too wide a range of issues, and should focus back on its primary objective of dealing with issues that affect the safety of either participants or CFOs. It was agreed that the complaints and issues log should be used to record all issues raised, and only those issues relating to safety should be escalated to the Disclosure Board, at the decision of the CFO manager.

Therefore, the following changes were finalised by the CFO manager in May 2016: three separate protocols were developed depending on the type of issue the CFOs were facing:

- **Technical Issues:** this protocol provides a simple and clear process to follow should the CFO receive a call pertaining to a technical query, with clear indication on what issues the CFOs can resolve, and what issues have to be escalated to a third party. It aims to facilitate a quick and satisfactory resolution, ensuring a fully transparent audit-trail where needed.
- **Customer issues and complaints:** this protocol provides clear guidance to the CFOs on how to capture and effectively manage any issue/complaint raised by a trial participant in a timely manner. It also clarifies at what point matters are to be escalated and shared with other project partners.
- **Disclosure Board (sensitive issues):** this reflects the original scope of the Disclosure Board, where a matter of a sensitive nature become known to the CFO, or the CFO is subject to abuse, racism, etc. by the customer. The purpose is to ensure safety of CFOs and project participants and it aims to establish clear protocols so any matter can be escalated immediately to relevant bodies such as the police and/or the social landlord, and to project partners so action can quickly be agreed.

8.2 Temperature monitoring

Temperature monitoring protocol

As previously described in the Final Energy Saving Trial report⁷⁶, a component of the project's approach to customer protection is the monitoring of temperature in participants' homes. Temperatures are being monitored both for trial effect (a significant different in temperature between the two groups – control and intervention) and condition effect (low temperatures in individual homes).

Trial effect

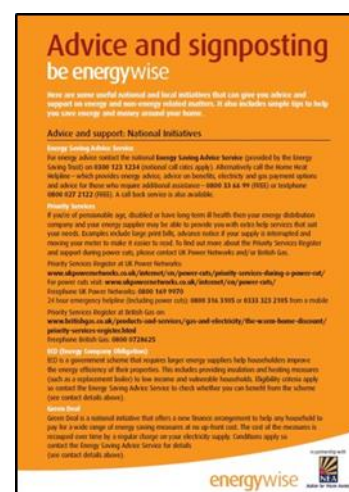


Figure 52: Consumer services charter

⁷⁶ The Final Energy Saving Trial Report", **energywise**, 2017, available from: <http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Energywise/Project-Documents/energywise+Final+Energy+Saving+Trial+report+v1.6+PXM+2017-05-24.pdf>

There was no evidence of a trial effect in Trial 1. Average temperatures for control and intervention groups were found not to have a statistically significant difference.

For Trial 2, a trial effect could, theoretically at least, manifest itself in temperatures in prepayment homes dropping during CPR events, especially if this effect were shown not to occur in credit homes. Analysis was carried out to test for temperature drops during CPR events. It was shown that there was no significant temperature drop during CPR events in prepayment homes (nor in credit homes). Therefore there is no trial effect.

Condition effect

The CFO manager is responsible for the temperature monitoring protocol, using temperature exception report data provided by British Gas and with University College London. These reports include, for identified properties, aggregated temperature data plus any vulnerability data they hold from the Energy Social Capital surveys. The CFO manager completes the risk assessment once the necessary data has been collated, with CAG Consultants then reviewing this. Both British Gas and University College London then review and agree any planned action to be carried out as a result of the risk assessment.

For winter 2017/18, exception reports were received for 12 participants. (Please note that not all active participants are transmitting temperature data; as reported in previous reports, due to recurring problems with the temperature monitoring equipment – caused by a mixture of technical issues and participant behaviour. Due to the frustration of some participants at having repeat visits to rectify problems, it was agreed that no further interventions would be carried out to rectify problems unless participants specifically requested it. For those participants for whom the project are still receiving data, exception reports continue to be monitored and agreed protocols followed.)

Where exception reports were received for a household, a risk assessment was undertaken for these households, taking into account:

- The number of days and individual periods for which exception reports were received;
- The degree to which the minimum temperature threshold was breached;
- Data regarding the vulnerability of occupants (e.g. very young, very old, health issues or disabilities);
- Whether the household is on a prepay meter;
- Any vulnerability data held by project partners including British Gas' and UK Power Networks' PSRs, housing provider data and plus CFO observations, e.g. age of occupants and health issues; and
- The likelihood the property was unoccupied at the time the temperature threshold was breached (based on the electricity consumption, with consumption below 1 kWh per day suggesting the property may be unoccupied).

The risk assessment categorised each householder as being at low, medium or high risk of suffering ill health due to the low temperatures observed.

Of the 12 participants for whom exception reports were received during winter 2017/18, only one was rated as high risk. The remainder were categorised as low risk due primarily to the short period they incurred low temperatures. For the one high risk customer, a courtesy call established that the participant had been away from the home during the periods of low temperature and was therefore not at risk.

8.3 Compliance to data privacy strategy and Comms Plan

As previously reported, the vast majority of actions relating to customer protection have been implemented as per the plan and strategy, with a small number of exceptions. These are listed below (Table 12), along with the alternative action taken and the rationale for this.

Table 12: Vulnerable customer actions and alternative actions

Action	Alternative action and rationale
Provision of Priority Services Register leaflet to all participants as part of the welcome pack.	It was found more appropriate to provide one point of contact for participants (i.e. direct line to Bromley by Bow Centre CFO team) to avoid confusion, while it was decided to advertise the PSR in targeted materials (such as the service charter for non-participants/leavers and the cold homes leaflet). In addition to this, it was also decided to test awareness of PSR in the ESC2 first, then include the information in the Newsletter 2018 issued to all trial participants and monitor any change in awareness through ESC3.
The team will keep a record of telephone conversations held with and enquiries raised by customers.	Recruitment inbound calls are recorded on the recruitment tracker. All other enquires have been recorded in hard copy and, from March 2016, electronically. Prior to this point, due to a period of sudden intense activity involving large numbers of CFOs and new customers, most enquiries were escalated immediately to the relevant partners.
At the point of sign-up and consent, each participant will be given or sent the project welcome pack and invited to attend a local drop in event.	Due to lack of attendance at first drop in event, further events were not held.
Regular project newsletter sent to Group 1 during Trial 1 and to both Groups during Trial 2.	First project newsletter was sent end of June 2016, once all the installations were been completed and the first participant panel meetings held, designed to respond to queries raised at the panel meetings. Newsletters were then sent regularly (approximately every three months) until the end of the project, with different versions for prepay and credit customers during Trial 2.
Once installation appointment made, this will be confirmed in writing with the participant by their preferred method.	Appointments have not been confirmed in writing. Many appointments have been booked the day before, making confirmation via writing not an option. Bromley by Bow Centre made the booking and passed this to British Gas for them to confirm the booking with customers.
All enquiries from participants will be shared between CFO team, UK Power Networks and British Gas with a tracker created for that purpose.	Customer enquiries have not been systematically shared with UK Power Networks. Enquiries have been directed to relevant partners (e.g. British Gas) via email or telephone. Enquiries tracker developed March 2016 due to key focus of Bromley by Bow Centre's CFO team on installation phase and on quick resolution of customer queries.
Participants asked to complete an exit survey.	Not always appropriate as some customers difficult to engage/talk to. They did not feel the need to explain reasons for not wanting to participate

Action	Alternative action and rationale
Customers who are blind/partially sighted and those on electrical medical equipment will not take part in the trial.	<p>These customers could only be identified after they had signed up to take part (and therefore consented to their data being shared). On reflection, project partners are in agreement that:</p> <ul style="list-style-type: none"> For those on electrically operated medical equipment, it would be better for these households to stay in the trial than to be disengaged, as there is no greater risk to them of losing electricity supply; indeed, they will be afforded better protection through being in the trial. It is therefore planned to keep them in the trial but ensure the CFO team and other partners are aware of the need to be very sensitive in their dealings with these customers, for example in terms of signing them up to the ToU tariff or asking them to complete surveys. For those identified as being blind/partially sighted, these customers can remain in the trial provided they are not the sole occupant in their household and also provided the customer field officers had also observed that the person signing up to the trial could read the project literature.
<p>Data Privacy Strategy</p> <p>Database B – University College London to appoint representatives that will have access to the personal identifiers, maintain a log each time access to personal identifiers is required, and obtained written approval from the Data Privacy Group in case the identity of the representatives needs to be changed.</p>	<p>Database B participant administration/management team have access to participant identifiers to maintain and update the University College London database as required and to deliver operational and research requirements (e.g. administration of surveys, updating dropouts) of the project. A log is not maintained as it is not pragmatically viable to do so given the constant and ongoing operational and administration tasks that require access to the personal identifiers in this database.</p>

9 Learning outcomes

The project to date has generated a wide range of learning outcomes. The learning outcomes reported below are in addition to the lessons reported in the Final Energy Saving Report⁷⁷.

9.1 Learning Outcomes: Customer Recruitment

#	Lesson Learnt
L1.1	<p><u>Trial 2 recruitment – phone calls versus door knocks:</u></p> <p>As part of Trial 1 recruitment, it was identified that most participants would trust communications from their supplier. Given the nature of the DSR trial, British Gas led on the recruitment for Trial 2 but they required extensive support from the CFO team to get hold of hard-to-reach customers. Also, whilst door knocks were found to be very successful in getting sign-ups at the outset of the project, it appears that once participants are already engaged and know the team at Bromley by Bow Centre, phone calls are more time and resource effective in terms of getting hold of people (different from Trial 1 recruitment). Door-knocks still proved useful for those hardest to reach.</p> <p>Customers are more likely to respond to a mobile number that appears on their screen than an 0800 number.</p>
L1.2	<p><u>Trial 2 recruitment – building on Trial 1 lessons:</u></p> <p>Key findings from the lessons learnt capture workshop on Trial 2 recruitment and installation phase included that:</p> <ul style="list-style-type: none"> - Building on learning from Trial 1, there is a smoother and more effective working relationship between British Gas and the CFOs. This included weekly update calls and, in latter stages of DSR recruitment, the ability to transfer participant phone calls directly to British Gas to enable sign-up; - The communication materials were well received by participants, particularly the shifting advice; - The complexity of having different offers and customer journeys for different groups, involving liaison with different partners, made the recruitment process quite resource intensive – though it was, overall, very successful; - The Bonus Time critical peak rebate is quite a complex offer and some participants required support to understand this from written communication alone; face to face communication is more effective in ensuring understanding; - Participants seemed to be more likely to respond to a call from the customer field officers (whose number appears on their phone as either a local landline or mobile number) than to British Gas (whose number appears as an 0800 number).
L1.3	<p><u>Method of sign-up to Trial 2:</u></p> <p>HEFT participants: 51% signed up through the initial call from British Gas whilst 49% signed up after support from the CFO team as well as a call with British Gas.</p> <p>Bonus Time participants: 66% signed up after talking to the CFOs while 36% signed up during the initial call with British Gas. (The process was simpler than for HEFT as participants could provide consent to either British Gas or the field officer team, whereas for HEFT they had to provide consent to British Gas).</p>

⁷⁷ "The Final Energy Saving Trial Report", **energywise**, 2017, available from:
<http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Energywise/Project-Documents/energywise+Final+Energy+Saving+Trial+report+v1.6+PXM+2017-05-24.pdf>

#	Lesson Learnt
L1.4	<p><u>Interactions before sign-up to Trial 2:</u></p> <p>The Trial 2 recruitment process was resource intensive. The different offers (HEFT and Bonus Time) and groups (control and intervention) required different customer journeys and different levels of interaction with the field officers and British Gas. This resulted in some participants being contacted several times. Wherever possible, the customer journey should be streamlined. Where contact is needed from two partners, ideally there should be a system to transfer a customer straight from one to the other. (This was introduced on energywise in the later stages of Trial 2 recruitment.)</p>
L1.5	<p>HEFT participants: 51% of those who signed up did so during the first three contact attempts by British Gas phone call; 18% during the first call, 15% on the second call and 18% on the third call. 20% of those who signed up did so after five contact attempts, with 5% signing up after 10 or more contact attempts (indicating the resource intensive nature of the sign-up process). 6% signed up after a door knock.</p>
L1.6	<p>Bonus Time participants: 45% signed up during the first three contact attempts with all participants signing up within nine or fewer contact attempts. (As mentioned above, the process was simpler than for HEFT as participants could provide consent to either British Gas or the CFO team, whereas for HEFT they had to provide consent to British Gas).</p>
L1.7	<p><u>Reasons for signup to Trial 2:</u></p> <p>Those at the panel and interviewed said that they signed up to take part in Trial 2 because:</p> <ul style="list-style-type: none"> - It was an attractive offer (all participants, though credit customers generally felt they were more likely to save money through HEFT than prepayment customers did through Bonus Time; many of the latter felt the savings were likely to be small). - They liked the idea of being involved in something novel/challenging (some participants).
L1.8	<p><u>Reasons for not signing-up to Trial 2:</u></p> <p>Of those saying no to Trial 2, the majority did not give a specific reason, but some credit customers said they didn't want to switch to HEFT either because their bills are generally low or they don't use much electricity. One said no because he believed the trial to be a trick. Of those saying no to receiving Bonus Time notifications, half (three) said no because they felt they were too busy to take part</p>
L1.9	<p><u>Engaging customers on ToU tariffs/rebates:</u></p> <p>Offering a non-punitive tariff was key to engagement.</p> <p>A static ToU easier for participants to understand than CPR; the simpler the DSR offer, the easier it is to engage people.</p> <p>Communicating Critical Peak Rebates to customers can be challenging, particularly in the case of vulnerable participants and/or those with limited English. Some participants really benefit from face to face communication. A video explaining the process would be beneficial. Testing the design before launching would be beneficial, e.g. investigating the impact of different pricing, event frequency, demographics, comms methods.</p>

#	Lesson Learnt
L1.10	<p><u>Scope for improving the recruitment approach:</u></p> <p>For Trial 2 recruitment, where possible have flexibility in terms of who the participants can provide consent to or enable automatic transfer of participants from one partner to another where this is not possible. (In the case of HEFT, which constituted a tariff change, consent had to be provided verbally to British Gas.)</p> <p>Call scripts should be kept as short as possible.</p> <p>Minimise interactions with customers by limiting the need for them to speak to more than one person as part of the signup process.</p> <p>Where different organisations are involved in the process, instituting daily calls helps ensure everyone is up to date in terms of the status of individual participants.</p>

9.2 Learning Outcomes: Drop-outs and Ongoing Engagement

#	Lesson Learnt
L2.1	<p><u>Project Drop Outs:</u></p> <p>Through regular communication with participants, minimising customer interactions and ‘hassle’ and using the regular participant panels to identify issues and test communications, since May 2016, only one participant has chosen to leave the project through requesting that their smart meter be removed. (Others have left because they have change supplier, moved house or did not want a smart meter installed at the start of Trial 2). This suggests that the ongoing engagement strategy has been effective.</p>
L2.2	<p><u>Ongoing Engagement – One to One Engagement by Field Officers:</u></p> <p>CFOs can be successful in persuading participants to remain engaged with the project. For example, during Trial 2, one participant contacted the field officer team asking to stop receiving Bonus Time notifications because the rebates he was earning were low. One of the field officers managed to persuade him to keep getting the text notifications but not the emails.</p>
L2.3	<p><u>Customer engagement through project closedown:</u></p> <p>Participants were sent clear communication about the process for end of the project with a timeline provided as part of the end of project newsletter. This helped to ensure that participants knew what to expect. All information sent out was tested with participants at the final participant panel meeting, and refined based on their suggestions.</p> <p>Participants were contacted to arrange collection of their temperature monitoring equipment, with a £10 voucher offered as a thank you. Equipment was only collected from around half of participants; others no longer had the equipment or failed to respond to calls to schedule appointments.</p> <p>It would have been useful to update contact details between partners; many phone numbers held by the project (which had been gathered at the start of the project, up to four years earlier) were out of date. The social housing providers would hold more up to date details for participants.</p>
L2.4	<p><u>End of project party:</u></p> <p>An end of project party was held for participants and their guests, with games, prizes and information on the project outcomes. Representatives from a range of project partners attended. Key learnings:</p> <ul style="list-style-type: none"> • A high proportion of those who say they will attend may not show up (50% in this case). • Participant feedback was very positive and it was felt that the party offered a valuable way of closing the customer journey. • The party enabled feedback to be gathered from a wider cohort of participants than those who typically attended the participant panel meetings. • Gift bags were provided to those who attended; these proved very popular.

9.3 Learning Outcomes: Installation Process

#	Lesson Learnt
L3.1	<p><u>Trial 2 installs:</u></p> <p>Key findings from the lessons learnt capture workshop on Trial 2 recruitment and installation phase included that control group installations generally went smoothly and were completed more quickly than in Trial 1, in part due to learnings from Trial 1 installations being implemented (such as making advance contact with social housing providers to identify properties requiring caretaker access to meters, and arranging this access ahead of the installation appointment).</p>

9.4 Learning Outcomes: Research aspect

#	Lesson Learnt
L4.1	<p><u>Qualitative Customer Insights – Trial 2 (Energy Shifting):</u></p> <p>The July and October 2017 panels have provided some practical, anecdotal insights into how the energywise participants are responding to their time of use tariff. In particular:</p> <ul style="list-style-type: none"> - Some loads are easier to shift than others, such as washing; - Participants found it useful to share tips on how to get the most out of the offer; - Participants attending these panels are in general positive about non-punitive tariffs and therefore all have been favourable to the project extension; and - Feelings about punitive tariffs are mixed. <p>There are currently 34 energywise participants who are not taking part in Trial 2. One of these was felt to be too vulnerable to take part in the DSR trial whilst the others said they did not want to take part (or would not respond to communications inviting them to take part). Where reasons were given for not taking part, these were either lack of time (particularly on Bonus Time) or existing low bills (particularly on HEFT). One customer stated that they believed the HEFT tariff was some kind of trick.</p>
L4.2	<p><u>Potential to Shift Electricity Use:</u></p> <p>Both participant interviews and the May 2017 customer panel provided some practical insights on how the energywise participants have started considering how best to reduce their electricity consumption and how they could shift the use of certain appliances into (or away from) the free periods (or the Bonus Time periods for prepayment customers).</p> <p>From the participants' anecdotal feedback reported in Section 2.4, the level of energy awareness seems to have increased as a result of the project's involvement. Some participants are able to make independent considerations on how to save electricity and how they can change their behaviour when responding to a specific tariff.</p> <p>However, in one case it was also found that the participant has misunderstood how the scheme works. This is still a valuable learning for the project as it allows the partners to provide tailored support to this individual and consider what actions to take with the wider group to check they got the correct interpretation of the tariff.</p>
L4.3	<p><u>Decommissioning:</u></p> <p>The CFO team are crucial to decommissioning process as this requires gaining entry to participants' homes to collect equipment. Participants were contacted to arrange collection of their temperature monitoring equipment, with a £10 voucher offered as a thank you. Equipment was only collected from around half of participants; others no longer had the equipment or failed to respond to calls to schedule appointments.</p> <p>Siemens decommissioning: Direct engagement by Siemens with the landlord to make logistical arrangements to arrange decommissioning appointment would have been more efficient than liaising via a facilitator.</p>

#	Lesson Learnt
L4.4	<p><u>Network Insights – Trial 2 (Bonus Time):</u></p> <p>The Bonus Time offering was associated with a 1.5% reduction in average weekday evening peak demand for all households involved in this trial. The level of reduction observed from different households varied considerably, with the best performing households (top 10%) achieving average demand reductions of 18.7% during Bonus Time events, which is consistent with the high levels of demand reduction achieved in other international trials of Critical Peak Rebate schemes.</p> <p>The availability of sufficient flexible demand is an important aspect of customer response for Critical Peak Rebate schemes like Bonus Time and it was found that the presence of larger flexible appliance loads (such as tumble dryers and electric cookers) had a significant impact on the level of demand reduction that was achieved by households during Bonus Time events. Customer understanding of the operation of the Bonus Time scheme is also important (with some participants mistakenly thinking they were supposed to increase demand during Bonus Time events rather than reduce demand).</p> <p>Much of the Bonus Time demand reduction was concentrated in the first three hours of the six hour weekday evening events most frequently tested (17:00 – 23:00). This front-loading of demand reduction aligned well with the average peak demand period (18:00 – 19:00) of the Bonus Time participants and the flexible nature of the Bonus Time approach means that events could easily be tailored to the specific peak time of each network asset.</p>
L4.5	<p><u>Network Insights – Trial 2 (HEFT):</u></p> <p>The HEFT tariff was associated with an average 2.2% reduction in the weekday evening peak demand of the monitored households. However, this tariff was also associated with an average 22.2% increase in the peak demand for the weekend day containing the HEFT free period. This has important implications for local network assets. At high HEFT tariff uptake levels among domestic customers, analysis found that many of the secondary substations involved could be subject to an increase in peak demand centred around a new substation peak during the HEFT free period. This impact was less severe for higher voltage level assets (e.g. primary substations) in which the impact is less apparent due to the contribution of industrial and commercial loads at these voltage levels.</p>
L4.6	<p><u>Technical potentials:</u></p> <p>The energy saving observed in Trial 1 from the energy saving devices provided to energywise participants (23 W peak demand reduction) compared well to that of the technical potential estimated from literature data (28 W when comparing on a like-for-like basis) reflecting the meaningful potential for engagement with energy saving devices among the fuel poor customers in this trial.</p> <p>The energy shifting observed in Trial 2 (1.5% average evening peak reduction across all Bonus Time participants) also aligned well with the technical potential estimate (1.5% based on a relevant large scale Critical Peak Rebate trial in the USA – appropriately scaled for the low incidence of domestic air-conditioners in the UK).</p>
L4.7	<p><u>Potential network impacts:</u></p> <p>If the energywise Trial 1 energy savings and Trial 2 Bonus Time energy shifting were realised by all households classified as fuel poor within the UK Power Networks licence areas, an estimated annual reduction in electricity consumption of 86 GWh/year (equating to a total saving to customers of approximately £11.2m/year⁷⁸) and a network peak reduction of 27 MW (equating to a potential deferred network reinforcement cost of between £2.7m and £5.4m) could be achieved across the three UK Power Networks licence areas.</p>

⁷⁸ Based on 13p/kWh.

10 Conclusions

10.1 Trial 2 Recruitment

A high proportion of participants (86%) signed up to take part in Trial 2 (with similar levels for the two different offers), showing that the propositions were well received. The recruitment approach built on learnings from the Trial 1 recruitment process, for example in terms of coordination of activities (with a daily call between key partners) and in terms of the best time of day to call (after 10am and avoiding the afternoon school run). This resulted in a smoother recruitment. Due to the CFOs' excellent knowledge of the project's participants, the recruitment approach could be tailored to the participant (for example phoning or door knocking at times of day the participant was most likely to be in). Participants were very positive about the materials, finding them to be accessible and fit for purpose. The shifting advice was well received with feedback that this is useful in helping participants respond to ToU tariffs and rebate schemes.

Learnings points from the Trial 2 recruitment process were as follows:

- Communicating critical peak rebates to customers can be challenging, particularly in the case of vulnerable participants and/or those with limited English. Some participants really benefit from face to face communication. A video explaining the process would be beneficial.
- Call scripts should be kept as short as possible.
- Customers are more likely to respond to a mobile number that appears on their screen than to an 0800 number.
- Minimise interactions with customers by limiting the need for them to speak to more than one person as part of the signup process.
- Where different organisations are involved in the process, instituting daily calls helps ensure everyone is up to date in terms of the status of individual participants.

10.2 Bonus Time

The Bonus Time offering was associated with a 1.5% reduction in average weekday evening peak demand for all households involved in this trial. The level of reduction observed from different households varied considerably, with the best performing households (top 10%) achieving average demand reductions of 18.7% during Bonus Time events, which is consistent with the high levels of demand reduction achieved in other international trials of Critical Peak Rebate schemes^{79,80}. Customers earned rebates ranging from £3 to £111 per year, with the average rebate comprising £37 per year.

Much of the Bonus Time demand reduction was concentrated in the first three hours of the six hour weekday evening events most frequently tested (17:00 – 23:00). This front-loading of demand reduction aligned well with the average peak demand period (18:00 – 19:00) of the Bonus Time participants and the flexible nature of the Bonus Time approach means that events could easily be tailored to the specific peak time of each network asset.

When considering the total amount of electricity consumption shifted out of the six hour weekday evening Bonus Time period, there wasn't a statistically significant shifting when considering the average across all Bonus Time participants⁸¹. However, when disaggregating this analysis for various household characteristics, it was found that households possessing larger flexible appliance loads (such as tumble dryers and electric cookers) did demonstrate a statistically significant shifting of electricity consumption across the entire six hour weekday

⁷⁹ "BGE's Smart Energy Pricing Pilot Summer 2008 Impact Evaluation", Baltimore Gas & Electric Company, 2009.

⁸⁰ "Ontario Energy Board Smart Price Pilot Final Report", IBM Global Business Services and eMeter Strategic Consulting, 2007.

⁸¹ The front-loaded demand shifting response of Bonus Time participants, which aligned well with the time of peak demand, may have contributed to the statistically significant peak demand reduction for weekday evening Bonus Time events while total electricity consumption across the six hour event did not demonstrate a statistically significant change. The small sample size of households available for the Bonus Time trial is also likely to have contributed to the limitations around statistical significance of the findings.

evening Bonus Time period. This finding confirms that the availability of sufficient flexible demand is an important aspect of customer response for Critical Peak Rebate schemes like Bonus Time.

Customer engagement and understanding of the operation of the Bonus Time scheme is also important with some participants reporting that they were not able to actively engage with the scheme and in some cases misunderstood the offer (e.g. some participants thought they were supposed to increase demand rather than reduce demand during Bonus Time events⁸²).

As this is the first time a Critical Peak Rebate scheme has been trialled in the UK, further work to understand the potential for peak demand reduction from Critical Peak Rebate offers (such as Bonus Time) among broader customer demographics appears warranted, particularly for customers with larger flexible demand loads. This has particular relevance given the likely increase in uptake of potential flexible loads from electric vehicle charging, heat pumps, air conditioning and smart appliances across domestic customers in the UK. Similarly, further testing of different Critical Peak Rebate reward levels and structures to ascertain the price elasticity of peak demand reduction among domestic customers in the UK would be valuable.

10.3 HEFT

HEFT participants on average shifted 0.92 kWh (equivalent to an average washing machine cycle) per week out of the paid time into the free time, saving 12p/week. The highest shifting from the paid to the free time was 8 kWh per week. Again, the presence large flexible appliance loads (i.e. tumble dryers and secondary electric heating) were among the factors associated with shifting.

The HEFT tariff was associated with an average 2.2% reduction in the weekday evening peak demand of the monitored households. However, this tariff was also associated with an average 22.2% increase in the peak demand for the weekend day containing the HEFT free period. This has important implications for local network assets. At high HEFT tariff uptake levels, analysis found that many of the secondary substations involved could be subject to an increase in peak demand centred around a new substation peak during the HEFT free period. This impact was less severe for higher voltage level assets (e.g. primary substations) in which the impact is less apparent due to the contribution of industrial and commercial loads at these voltage levels.

Interview feedback indicated that the HEFT tariff was an easier flexibility product for participants to understand and respond to. However, some participants did misinterpret the HEFT offer, or reject it when they could have benefited from it.

10.4 Energy Social Capital

energywise also measured participants' 'energy social capital' – i.e. the social resources they had available to help them save or shift energy.

- The number of people stating they had at least one person to ask about various energy saving and shifting issues increased throughout the project to 90%.
- Family members were most frequently identified as suitable to ask for advice.
- After the shifting trial, more conversations were reported about shifting the times at which energy is used.

Feedback also indicated that 95% of participants were either satisfied or very satisfied with the project and 95% feel it has benefited them.

⁸² It is not clear why this misunderstanding occurred since for each Bonus Time event, the customer notifications all clearly stated to "Use LESS electricity in this period to get credits" and to "REDUCE your electricity use in this period to earn credits". This messaging was also repeated in trial setup communication, newsletters and any personal contact. The Bonus Time trial is the first time a Critical Peak Rebate offering has been tested in the UK, so it may be the lack of precedence for this kind of scheme in the UK that contributed to confusion among some customers. Further clarification in this area may be required in future deployments of Critical Peak Rebate schemes in the UK to ensure full customer understanding of the fundamental scheme principles.

10.5 Wider Potential

If the **energywise** Trial 1 energy savings and Trial 2 Bonus Time peak reductions⁸³ were realised by all households classified as fuel poor within the UK Power Networks licence areas, an estimated annual reduction in electricity consumption of 86 GWh/year could be achieved in total (equating to a total saving to customers of approximately £11.2m/year⁸⁴) and a network peak reduction of 27 MW (equating to a potential deferred network reinforcement cost of between £2.7m and £5.4m)⁸⁵. While the consumption profiles of those in Tower Hamlets differ from those with some similar characteristics in other parts of the UK – there is no evidence suggesting that proportionally similar energy shifting would not be observed in other DNO regions.

⁸³ The Bonus Time impact on peak reduction was used rather than that of HEFT due to the potential creation of new secondary substation peak loads during the free electricity periods of the HEFT tariff. Please see Section 6.3.3 for further details.

⁸⁴ Based on 13p/kWh

⁸⁵ These savings and deferred costs would need to be offset against the cost of engagement, devices, rewards and scheme administration associated with such wider scale interventions.

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Appendix A: External Control Group

The process for selection and recruitment of the external control group was refined and simplified to maximise the similarity with the participants in the Tower Hamlets study area.

The process contained three key steps and can be summarised as follows:

- Firstly, British Gas applied their fuel-poverty indicator constructed from data held across different British Gas business systems. This creates a subset of 'fuel poor' customers.
- Secondly, the eligibility screening criteria used to select customers in the Tower Hamlets study area were applied. These screening criteria included: gas central heating smart meter customers for which there is data back to 1 January 2016. This eliminated customers on electricity heating tariffs such as Economy 7 or 10, and those on district heating schemes. This creates a subset of **energywise** fuel poor customers.
- Finally, all remaining eligible customers were approached to participate on an opt-out basis.

These customers were grouped into "DNO climate regions" of which six were identified within Great Britain. These climate regions were determined by climate factors and minimise variation within each region by the key determinants driving variations in electricity use including variation in daylight hours, heating degree days and cooling degree days. Of the six climate regions, one Northern Scotland, had significantly too few eligible customers (99) to allow for construction of an estimate of the energy savings likely to arise in that region using the same methodology is used for other climate regions. Consideration was given to grouping the climate regions of Southern Scotland and Northern Scotland together, however due to the significant climatological differences (particularly differences in daylight hours) made this unjustifiable. For this reason, the estimates of the savings arising in northern Scotland Northern Scotland, has been initially based on that of Southern Scotland. This is a project constraint arising from the geographical distribution of the project partner's (British Gas) customer base.

To estimate required numbers, prior calculation of the final required numbers per DNO climate region was undertaken. This arrived at a figure of 680 per climate region. Once allowing for recruitment refusals, dropouts, supplier changes and tariff changes this figure was inflated to 960 per climate region. This figure was determined by the need to estimate any potential contamination effects arising within the trial, and to be able to tell DNOs replicating the approach that the method can say with the project's agreed levels of statistical power and confidence their expected energy savings to within 100 kWh. This figure exceeds the requirement in the bid document of calculating external validity using 5% margin of error and a 90% level of confidence (a final sample size of 680 provides a 3.1% margin of error at the 90% level of confidence). Ultimately however, once screening for issues of zero or negative reads was conducted, the levels of useable data fell below these levels. To assess the impact of this on the findings, tests were run to determine the relationship between energy demand and response to time shifting signals used in Trial 2. As no relationship was found, it was concluded that there was no reason to believe that participants' capacity to shift energy varied as a function of their baseline average half-hourly energy consumption.

External control group participants were recruited during April and May 2017, however their smart meter data is available back to the start of 2016 to allow for analytical comparison with participants in Tower Hamlets.

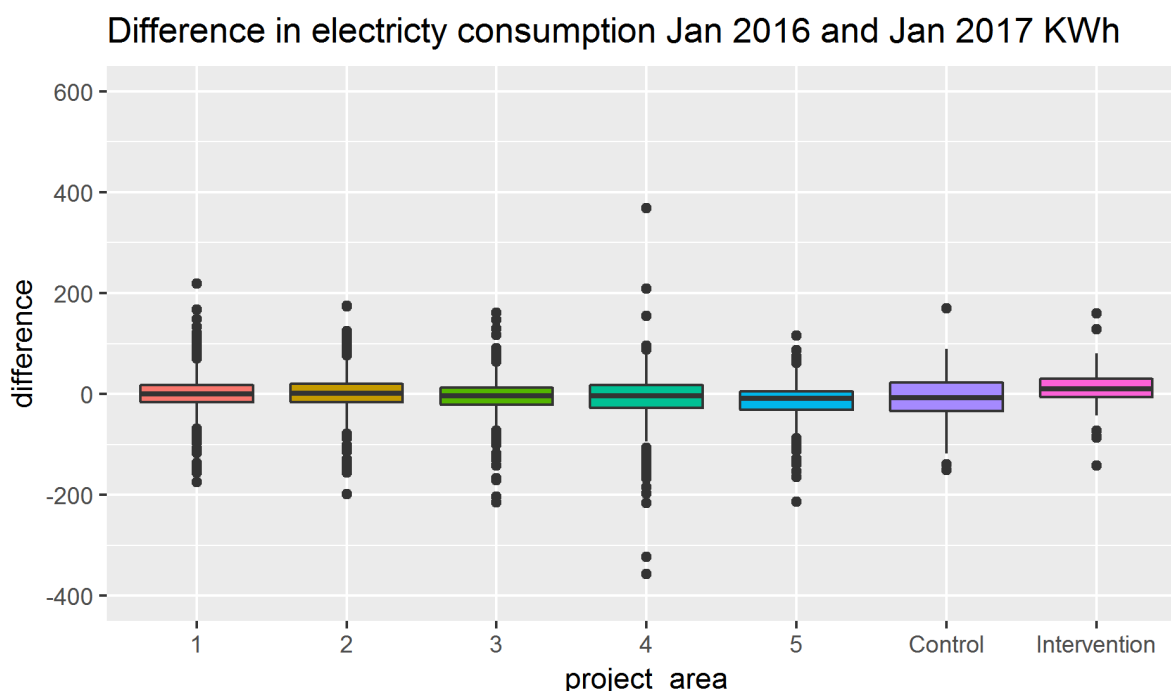
In Section 5.3 of the Final Energy Saving Trial report⁸⁶ it is shown that there were no observable contamination effects between the intervention and control group thus supporting the generalisation of the finding to the different DNO climate regions and hence to the different DNO areas in Great Britain.

An additional form of analysis for contamination effects was carried out with the data from the external control group. An analysis of variance (ANOVA) test was conducted across the five climate regions into which the external control group data was aggregated, with the intervention group in Tower Hamlets. It is important to note here that the external control group data is primarily required for Trial 2 and hence contains British Gas customers with dual

⁸⁶ "The Final Energy Saving Trial Report", **energywise**, 2017, available from:
<http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Energywise/Project-Documents/energywise+Final+Energy+Saving+Trial+report+v1.6+PXM+2017-05-24.pdf>

fuel or electricity smart meters – they are therefore expected to behave in a manner similar to those in the intervention group in Tower Hamlets (not the control group for Trial 1).

For the purposes of assessing contamination, outliers in the external control group climate regions were defined using the Tukey method on the percentage change in consumption, and all values outside 1.5 times the Interquartile range were removed. Outlier detection resulted in 315 observations being removed approximately 8% of the total. The analysis of variance test of the data across all regions' smart metered participants showed that there was no significant difference in the **change** in the means of the groups' consumption between January 2016 and January 2017. This shows that the intervention group in Tower Hamlets behaved in a statistically similar manner to smart meter customers in each of the other climate regions across Great Britain. This can be seen in the box-plot below.



In this figure:

- Area 1 includes the UK Power Networks areas East England, London and South East England, as well as Southern England (Southern Electric Power Distribution).
- Area 2 includes the Western Power Distribution regions of the East and West Midlands
- Area 3 includes North West England (Electricity North West); North Wales, Merseyside and Cheshire (Scottish Power Energy Networks) and South Wales (Western Power Distribution)
- Area 4 includes the Northern Power Grid areas of Yorkshire and North East England
- Area 5 covers South Scotland (Scottish Power Energy Networks)

Further analysis (below) shows both the shape of, and variation between, mean monthly electricity consumption across the DNO climate regions in Great Britain. It is important to note that the sample sizes underlying these lines vary considerably, with the five climate regions each having around ten times the numbers of participants of those in the Tower Hamlets intervention and control groups. It is also possible to see the greater variation between regions over winter than summer (although the seasonal percentage variation between the regions is broadly similar).

