energywise

(also known as Vulnerable Customers and Energy Efficiency)

SDRC 9.3 Report

Results from the first six months of the energy saving trial

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Delivering your electricity

"It's a very good project, it's very useful. You can manage your budgets much better. The meter helps me to know where I'm at."
energywise participant

"I'm on a pay as you go meter – it's great to see on the energy display how much energy I'm using, and when I need to top up."
energywise participant

"The people who came and knocked on my door were very nice; I don't usually like it when people come to her door, but they were very nice and it didn't take too much for them to persuade me to sign up."
energywise participant

"Everything has run smoothly. I think the new meters are good. I've heard the scare stories, but I wouldn't want to change it."
energywise participant

"I'm using the standby saver on my TV, with the Sky set and consoles. The kids moaned a bit that they have to wait a bit in the morning for everything to come on, but I told them that we were wasting lots of money having it on all night, and they've got used to it now."
energywise participant

"The eco-kettle is brilliant. You can just fill up what you need, rather than too much."
energywise participant

"I wasn't sure of the offer when I read the letter, and had never heard of **energy**wise, but an amazing lady came and explained in detail the process and that it would fit around my schedule. I'd never go back."
energywise participant

This report summarises the first size months of the energy saving trial and addresses the Successful Delivery Reward Criteria 9.3 "Energy Saving: Impact of energy saving trial interventions – level of fuel poor participation and network impacts" set out for the Vulnerable Customers and Energy Efficiency project, also known as **energy**wise, in its licence direction:
https://www.ofgem.gov.uk/sites/default/files/docs/2014/01/vcee_project_direction.pdf

*In this page: quotes from **energy**wise participants on their experience within the project so far.*

Contents

Glossary

Term	Description
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
Customer Field Officer (CFO)	The intermediary hired by the project to be the contact for participants, and the 'face' of the project. The 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
DBS	Disclosure and Barring Service
DNO	Distribution Network Operator, responsible for managing one or more of the fourteen electricity distribution networks in Great Britain, delivering electricity to customers
DSR	Demand Side Response, a series of schemes where customers are encouraged to lower or shift their electricity use at peak time through various methods (e.g. financial incentives)
EAC	Estimated Annual Consumption
EELG	Element Energy Load Growth (model)
EPC	Energy Performance Certificate
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
EV	Electric Vehicle
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.
HEUS	Household Electricity Usage Study
HES	Home Energy Survey
In Home Display (IHD)	The display unit that accompanies the Smart Meter that displays the energy consumption and cost of energy unit. It is also known as Smart Energy Display (SED)
Intervention Group	This is the group exposed to the treatments (interventions) in Trial 1
LCL	Low Carbon London
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
Loop monitor	The electricity monitoring equipment installed in prepayment control group households. It consists of a clamp connected to the standard meter tracking the electricity consumption. It is configured to return half hourly readings intervals
LPN	London Power Networks plc, who are a DNO
MDU	Multi 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 MDU 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
QA	Quality Assurance
RTD	Real-time Display

Term	Description
RTU	Remote Terminal Unit
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)
Smart Energy Expert	The appropriately trained engineer of British Gas tasked to install smart meters according to the Smart Meter Installation Code of Practise (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
SMETS	Smart Meter Equipment Technical Specifications
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, the official title of this project as registered with Ofgem

1. Executive Summary

In December 2013, UK Power Networks was awarded £3.3million 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 **energy**wise. The **energy**wise project will investigate how DNOs, in collaboration with an energy supplier, 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 Companies Obligation (ECO) has understandably had to rely on interventions with measurable and proven impact or efficacy. The benefits of installing, for example, cavity wall insulation or loft insulation have been measured and tabulated[1]. In that sense one of the purposes of the project has been to try to put energy efficiency initiatives such as **energy**wise on a similar footing, so that government and other interested parties are better informed in this area.

However, to date there has been a limited evidence base of the benefits that can be achieved by the fuel poor 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 need of the fuel poor customers and explore the means to engage with them to facilitate increased participation in energy saving and Demand Side Response (DSR) campaigns. Within 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 meter sets and monitoring equipment in all participants' households, in 2015 the project commenced the first trial, which aims to identify any change in the household energy management behaviour, and the impact on the electricity network, that can be realised through energy efficiency measures.

This report addresses the third Successful Delivery Reward Criteria (SDRC 9.3: Energy saving) and is focused on the results from the first six months of the energy saving trial (defined as August 2015 to January 2016) and on the insights on customer protection gathered by the project to date. It is intended for:

- Policy makers and consumer groups interested in early results from the trial;
- Policy makers, energy suppliers and distribution network operators (DNOs) looking to understand the issues with rolling out smart meters to this part of the community;
- Other DNOs and researchers developing or running trials with residential customers.

In order to successfully engage and support the trial participants in achieving their energy saving potential, it is fundamental to gain a greater understanding of the households' demographic and their specific needs. The project has gathered valuable insights on the customer base participating in the trials through the analysis of two energy surveys, two customer panels, 30 telephone interviews and 97 notes of conversations captured with residents.

The demographic analysis has shown that the majority of the **energy**wise participants are Bangladeshi (with a large representation of 154 households out of 278 survey respondents) or White British (58 out of 278). This is reflected in the primary language spoken at home, being mainly English, Bengali or a combination of the two.

The **energy**wise households appear to be larger than the general population, showing a broad age distribution with some potentially vulnerable households having at least one child under 5 and/or elderly customers above

[1] https://www.ofgem.gov.uk/sites/default/files/docs/2015/10/eco2_measures_table_-_oct_2015-_v2_3_-_final.pdf

65. Income is generally low, with several households receiving housing benefits and child benefits, followed by income support and/or other state benefits.

The distribution of participants over different ethnic groups and age bands, together with the high volume of participants speaking Bengali as primary language (114 out of 278 respondents), suggest that the **energy**wise recruitment and engagement strategy was inclusive to all and that the project's innovative approach based on partnership working with trusted local intermediaries with local intelligence and language skills was suitable for the target population.

The report also summarises key findings around the level of trust of trial participants in general and within the trial area, their attitude towards energy advice seeking and towards the energy saving technologies provided by the project. Capturing any feedback they may have on **energy**wise and understanding who they trust and where they would turn to for energy advice and information is important to shape the ToU tariff trial and to constantly improve the project's engagement strategy.

However, these findings are not only informing the **energy**wise trials, but also will inform the industry on best practises to engaging hard-to-reach and diverse customers in the smart meter roll-out and similar energy efficiency campaigns. Given the diversity of Great Britain's population an inclusive approach will support the Government's target of fitting 53 million smart meters in over 30 million premises (households and businesses) by the end of 2020.

Additional customer insights on a broad range of topics including the use of heating and top-up of prepayment meters have been captured through different channels of interaction with trial participants. These are fundamental to contextualise their energy consumption and to inform the energy saving and shifting analysis. For instance, the project has gathered anecdotal evidence of different electricity patterns, such as the use of secondary electric heaters or the fact that extended family members moving between households; these habits are important factors to consider in the data analysis as they may alter not only the pattern of electricity consumption, but also the appliances in the home.

The analysis of the trial participants' electricity consumption based on six month worth of data, specifically daily meter reads from credit customers, has found no statistically significant evidence of energy saving in Trial 1 (with the limited dataset available for this report).

A difference in previous year annual energy consumption and household size has been identified between the control and intervention groups. However, preliminary analysis has shown that correcting for these two factors did not yield statistically significant savings realised by the intervention group with the limited data currently available. As such, further analysis of the impact of these factors will be conducted when the full set of Trial 1 data is available. With more data available and refined analytical methods, it is possible that future reports will find evidence of energy saving realised through the provision of smart metering solutions and energy efficiency measures.

An update report that will document the lessons learnt from analysing the 12 month trial data will be published in December 2016.

The December report will also provide an update on the network impacts associated with the potential savings achieved by the trial participants. The preliminary analysis of the network data in conjunction with the **energy**wise participant profiles has shown a strong correlation between their demand profile with the mean secondary substation load profiles, which indicates that energy saving and peak shifting responses from the trial participants have the potential to directly benefit the secondary substations to which they are connected.

From comparison with data from previous trials, it can be seen that the average consumption of the **energy**wise trial participants is considerably lower than that observed in other projects, such as the Low Carbon London

(LCL) and Customer Network Led Revolution (CLNR) trials, over the same calendar months. This is in line with the findings of the LCL trial analysis of the impacts of household income on average diurnal consumption profile and reflects the demographic composition of the participants in the **energy**wise study, which is targeted at fuel poor customers.

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 that has been developed in order to achieve these objectives and the innovative learnings that are expected to be gained through the trials;
- Section 3 summarises the way the project identified potentially fuel poor customers and describes the type of households recruited to the project reporting the analysis of the data collected via two research surveys;
- Sections 4 introduces Trial 1 with an overview of the energy efficiency interventions and their provision to trial participants during the installation phase of the project; the successful demonstration of the innovative Multi Dwelling Unit (MDU) Communication Infrastructure to commission smart meter sets to tall and difficult buildings is also illustrated;
- Sections 5 and 6 present the analysis of the electricity and network data available over the six months between August 2015 and January 2016 and the learnings gained so far;
- Section 7 illustrates the technical potential associated with Trial 1 interventions to obtain a sense of the scale of energy savings that could be realised by the end of the trial, while 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 learnt captured through the set-up and operational phases of Trial 1, through the research study and interactions with trial participants; and
- Appendices A and B finally detail some useful data quality checks developed for the analysis of the electricity consumption data and the selection strategy for the external control group.

Table 1 describes what has been achieved to date by the project as part of the energy saving trial. Appendix C illustrates how each evidence item for the Successfully Delivery Reward Criterion 9.3 has been addressed in this report.

Table 1: What we set out to do and what we have achieved to-date

Energy Saving Trial	
What we have set out to do	**What we have achieved to date**
• Quantitative analysis of Trial 1 energy savings through within-trial intervention-group to control-group comparison.	• A six month view of the quantitative data analysis of Trial 1 energy savings through the comparison of the within-trial intervention group to control group. The analysis is based on the data available at the end of the six month period starting from 1 August 2015 to 31 January 2016 and it is therefore focused on daily meter reads from credit customers.
• Quantitative analysis of Trial 1 control-group contamination effects through within-trial control-group to external to trial control-group comparison.	• Analysis of the contamination effects between within-trial intervention and control group. This focused on the identification of evidence of any potential selection bias or differential attrition between the two groups, which are the two main effects that may have had an impact in the first months of Trial 1. • Finalisation of the selection strategy of the external control group that will be used at the end of Trial 1 to identify any contamination occurred on course of the trial.

Energy Saving Trial	
What we have set out to do	**What we have achieved to date**
• Statistical generalisation of the energy savings to the wider UK Power Networks, British Gas and national fuel poor customer base.	• Definition of the strategy to assess the statistical generalisation of the findings once Trial 1 is completed. A ~93% confidence in generalising the potential savings achieved by intervention group to the wider population was estimated based on the volume of active participants.
• Representation of network impacts through half-hourly network modelling within the trial area.	• Half-hourly network modelling undertaken within the trial area with the six month worth of data available from Trial 1. • Under the scope of the project the Element Energy Load Growth Model was specifically modified to address fuel poor household archetypes in the domestic sector. • Comparison of the **energy**wise participants demand profile with the ones observed in the LCL and CLNR projects to identify any specific features of the **energy**wise customer base. • Half-hourly load profiles at primary and secondary substation level were compared with the **energy**wise participants profile to identify the impact of potential energy savings on the network.
• Comparison of realised energy savings against previous estimates of technical potential energy savings in the fuel poor customer group.	• Re-assessment of the technical saving potential for each of the Trial 1 intervention devices to obtain a sense of the scale of energy savings that could be realised in Trial 1. The identified theoretical potential savings will be compared with any realised energy savings observed at the end of Trial 1.
• Insights on customer protection during the trial.	• Completion of customer protection activities including a regular review of the vulnerability status of trial participants, development of procedures to capture and escalate customer issues, two customer panels and the temperature monitoring protocol. The outcomes of all the customer protection activities in place to ensure the project has no harm on the trial participants are discussed. The project also monitored compliance to the project's Communication Plan and Data Privacy Strategy.

Introduction

2.1 The Project

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

Figure 1: Project Brand

energywise is exploring 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 is doing this by undertaking a research study with the aim to recruit 550 households who may be struggling with their energy bills in the London Borough of Tower Hamlets and carrying out two trials. The trials will test 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 is currently exploring 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 standby saver.

Second, the project will work to understand households' appetite to change their behaviour when on a 'time-of-use (ToU)' tariff targeting electricity, with favourable rates within specific time windows.

Figure 2: Project's Strapline

The project plans to understand:

- The extent to which this residential customer group is able and willing to engage in energy saving campaigns and a ToU tariff;
- 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 and engaged in energy saving initiatives. It also illustrates key insights into the demographics of trial participants, the way they use energy, their level of trust in the area and their attitude towards energy advice seeking and energy saving technologies; as a result, the report provides a greater understanding into this customer base that will inform best practises to engaging hard-to-reach customers in the smart meter roll-out and similar energy efficiency campaigns.

2.2 Project overview

The project is engaging fuel poor customers to understand how they can benefit from energy efficiency measures[2] and whether they can reduce their electricity consumption at peak times through a ToU tariff (known as 'DSR'), generating both customer and network benefits.

[2] In this report the term 'energy efficiency' also encompasses 'energy conservation'.

As of 14 June 2016, 329 participants are actively participating in the project, which are all social housing tenants in the London Borough of Tower Hamlets apart from one leaseholder. **energy**wise is structured in two trials:

- **Trial 1,** which commenced in 2015, involves smart meters and energy saving devices (including 3 LED light bulbs, one eco-kettle and one Standby Shutdown). It aims to identify the magnitude of energy savings and the impact on the electricity network when customers have access to smart meters, smart energy displays, simple affordable energy saving devices and energy saving advice with existing tariffs.
- **Trial 2,** which will run mainly in 2017, involves giving participants a ToU electricity tariff. It aims to assess the level, and impact on the network, of demand shifting achieved through the introduction of a ToU tariff in parallel with energy-saving activities.

Trial design

Figure 3: Customer journey for group 1 and group 2 participants within project trials illustrates the research design of the two trials: trial participants are randomly allocated to two groups, group 1 (intervention) and group 2 (control). By the beginning of Trial 2 both groups receive the same interventions (highlighted in pink and orange) but at different times:

- 'Drip feed' approach (illustrated in pink): intervention group received the smart metering solution and the energy efficiency pack at the beginning of Trial 1 and will receive the DSR interventions in Trial 2;
- 'Big bang' approach (illustrated in orange): control group will receive all interventions at the beginning of Trial 2.

At the beginning of Trial 1 a temperature monitoring equipment was also installed in all participants' properties and two research surveys, the Energy Social Capital (ESC) survey and the Home Energy survey (HES), have been carried out with both groups. The Energy Social Capital survey will be administered again between the two trials and at the end of Trial 2 in order to identify any evolution of the research findings throughout the project.

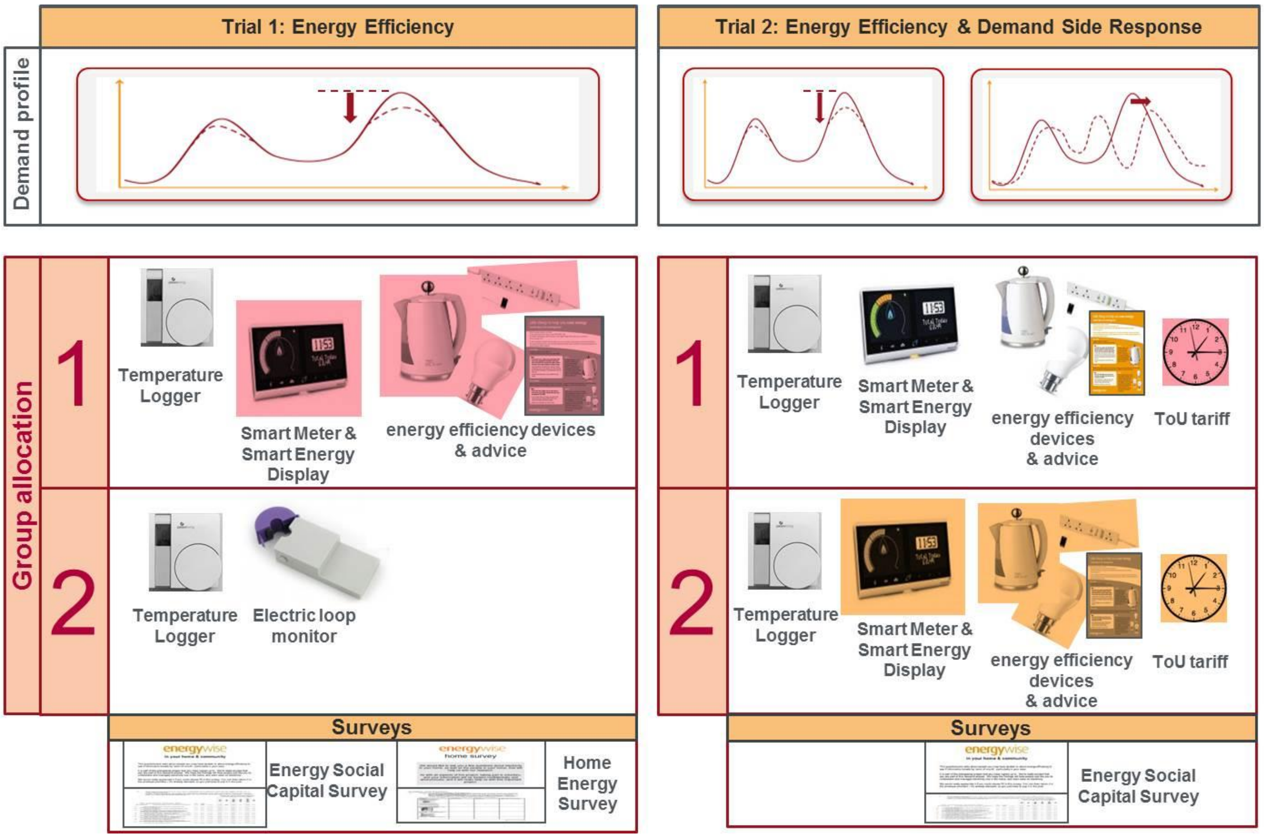

Figure 3: Customer journey for group 1 and group 2 participants within project trials

2.3 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. 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 **energy**wise 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 customers[3]. Figure 4 shows how electricity demand in the UK varies over a typical day[4]. 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.

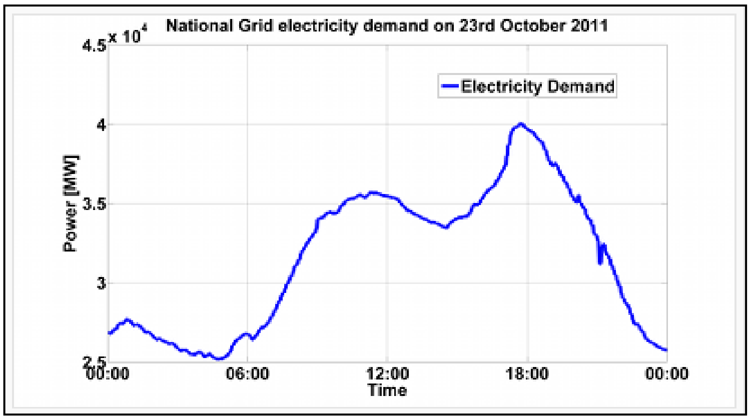

Figure 4: Electricity demand over a 24h period

- **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.

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 year[5]. Analysis of these figures suggest that a peak shift for fuel poor households of up to 200MVA across

[3] 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
[4] Based on National Grid data prepared by Glasgow University - http://www.physics.gla.ac.uk/~shild/grid2025challenge/data.html
[5] Source: DECC, Defra and the EST (2012), "Household Electricity Survey: A study of domestic electrical product usage".

Great Britain is technically possible[6]; this is the equivalent to the output from a small-to-medium sized power station. These figures were based on owner occupiers whereas **energy**wise focuses on social housing tenants; this project is beginning to fill this gap in data. They are also based on assumptions about occupant behaviour rather than observations and thus are not strictly speaking comparable with the findings of field trials.

2.4 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 approach between different parties in the value chain (i.e. exploration of enhanced services during a power outage). 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 DNOs 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 output will provide a strategy for DNOs to 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.

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 It is anticipated that this approach will lead to improved access rates for British Gas' Smart Energy Experts, greater community engagement and increased customer awareness of the benefits of smart metering, whilst lowering missed appointment and no-access rates.

<u>Smart meter roll-out insights</u>
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 **energy**wise, British Gas is testing its first SMETS1 compliant smart meters with prepayment functionality, outside their trial environment (with 66 prepayment smart meters installed so far in Trial 1). This is providing an opportunity to gain some 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

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

convenient payment options to customers (e.g. over the phone, online of 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 or 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 have not been able to fully access the benefits of the smart metering solution otherwise. 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 been fully resolved as part of the smart meter implementation programme and the 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.

3. Trial participants

This chapter provides an introduction to the **energy**wise trial participants, illustrating how they have been selected, recruited and allocated to the intervention and control groups. 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 3.6), which investigates both individual and collective energy social capital of **energy**wise households.

3.1 Selection and recruitment of trial participants

<u>Selection criteria</u>

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 line[7]. However, the project will also assess participants' fuel poverty status in accordance with the 10% definition for comparative purposes, as the Government continues to measure according to that indicator as well.

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 customers[8];

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

[8] 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

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

In addition, **energy**wise 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;
- Leaseholders and other non-social tenants[9];
- Households for which British Gas does not have annualised electricity consumption data for the year ahead of the pilot study;
- Households that had different occupiers 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 8.1.2 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 theft history;
- 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 criterions, 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.

<u>Trial 1 recruitment</u>

As a result of the selection process, a total of 1,342 households have been approached as part of the recruitment phase between the beginning of May and mid-August 2015 following the protocols described in the SDRC 9.1 report and in the previous progress reports. Out of the 1,342 households approached, 536 signed up to the project, resulting in a 40% response rate, which exceeded the target of 33%. 579 households (43% of the

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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.

9 One leaseholder has been included in the project to demonstrate the MDU Communication Infrastructure, as illustrated later under “Trial 1 recruitment” in this Section.

1,342 approached) said they were not interested in the project, while 227 households never expressed a definitive decision about participating in **energy**wise (Figure 5). When calculating the response rate for each sub-category, a similar response rate was observed between Tower Hamlets Homes (40%) and Poplar HARCA (39%) tenants, while prepayment customers have responded slightly more positively to the project (44%) compared to credit metered households (38%).

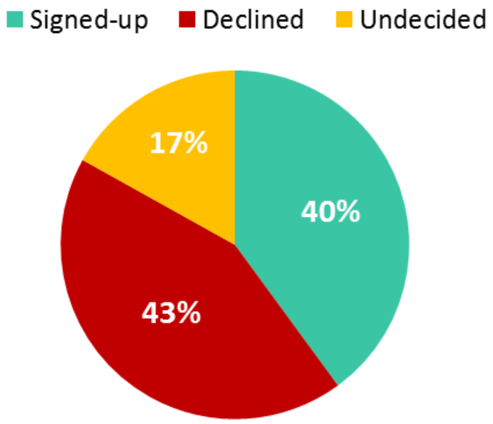


Figure 5: Trial 1 recruitment response rate (1,342 households in total)

As part of the recruitment of the 1,342 approached households, the project successfully recruited three households with properties in Padstow House, the MDU selected for testing the MDU communications infrastructure; however, it was found that two of these three did not require the MDU communication infrastructure as the flats were located adjacent to, or directly above meter rooms. The third customer had borderline Zigbee signal so may or may not require the MDU solution but was later disengaged by the project due to other ineligibility reasons.

In order to ensure robust project learnings around the innovative MDU communication infrastructure for tall and difficult buildings, British Gas re-ran the customer list within Padstow House and highlighted 10 additional customers that could potentially join Trial 1. Four of these customers matched all eligibility criteria but six were leaseholders. The project decided to allow leaseholders to be recruited only under these specific circumstances to maximise take up and demonstrate the effectiveness of the MDU communication infrastructure. Any leaseholder recruited for the purpose of testing this innovative solution will be flagged up in all project trackers and data analysis to make sure that they are treated appropriately in any assessments. This second wave of recruitment was conducted from the end of March 2016 until 18 April 2016 and it successfully signed up two customers who require the MDU solution to benefit from smart meters resulting in a total of 538 sign-ups to the project.

In total five households in Padstow House were successfully recruited for the project, of which two are eligible for the MDU, two do not require the MDU solution and one was removed due to ineligibility reasons.

Random allocation

Following the random allocation process designed by the research partner, out of 538 sign-ups, 268 were randomly allocated to customer group 1 which is Trial 1 intervention group and 265 to group 2 which for Trial 1 are the control group, while the five households recruited within Padstow House were assigned to the intervention group in order to test the MDU solution.

As of 14 June 2016, 209 households have dropped out from the project, which are almost evenly split between the intervention (102) and control (107) groups, resulting in fairly balanced active participants between the two groups (171 in the intervention and 158 in the control group, as shown in Table 2). Three households are currently going through a retention process; therefore their withdrawal is still unconfirmed. With 209 confirmed drop-outs, the total number of active participants in Trial 1 amounts to 329 households, of which are 278 Tower Hamlets Homes tenants and 51 are Poplar HARCA tenants, while 212 are credit customers versus 117 prepayment customers.

Table 2: Breakdown of Trial 1 participants into intervention and control group

Payment Method	Intervention	Control	Current Total
Credit	111	101	212
Prepayment	60	57	117
Grand Total	**171**	**158**	**329**

The results presented in this report, specifically the insights collected through the research surveys, the quantitative analysis of the electricity data and the network modelling, are based on the data available from a sample of 337 trial participants, those still active as of 31 January 2016. Out of these, 173 were in intervention group and 164 in control group, while 218 were credit customers and 119 prepayment customers. Given the evolving volume of drop-outs, this approach allowed the research partners to identify a common dataset and compare the research findings in a consistent manner.

3.2 EPC rating

Figure 6 shows the distribution of the 329 active participants to date into Energy Performance Certificate (EPC) rating bands C-G. Overall, 42% are in band C, 41% in band D and 17% in band E to G (with a small number of properties in band F and G). Even though those households that have had energy efficiency improvements since October 2013 have been excluded in the selection, the lack of very inefficient properties may be due to improvement works carried out by the social housing associations before that date. When the EPC ratings were not available, they have been extrapolated against the data available in the social housing associations' databases (e.g. taking the average EPC rating of properties on the same floor or in the same building).

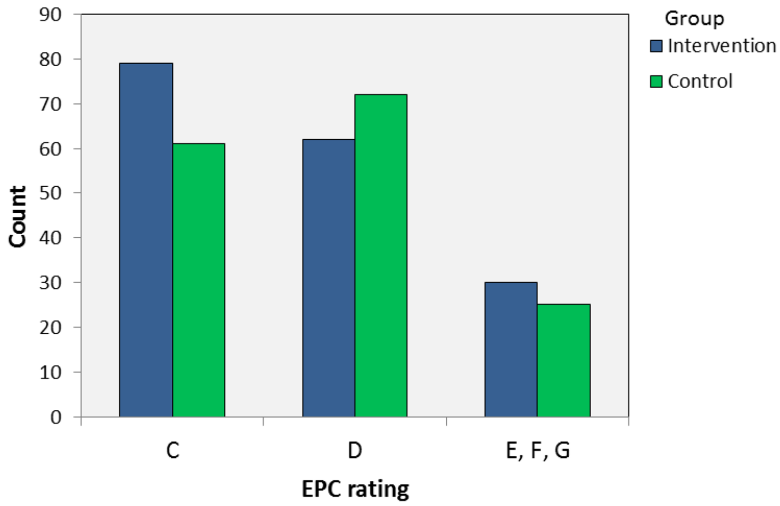


Figure 6: Number of properties in each band of EPC rating

3.3 Home Energy Survey

95% of Home Energy Surveys (HES) were completed with customer field officers (CFOs) assisting participants (e.g. counting lightbulbs, identifying appliance-types) with completion of the survey during visits to participants' homes in the installation phase of the project. A small number of surveys (5%) were left with participants for self-completion.

As of 31 January 2016, 334 HES had been returned, of which 56 participants had dropped out of the project. Therefore, the analysis in Sections 3.4 and 3.5 below is based on 278 HES eligible for inclusion in this report with 138 in the control group and 140 in the intervention group.

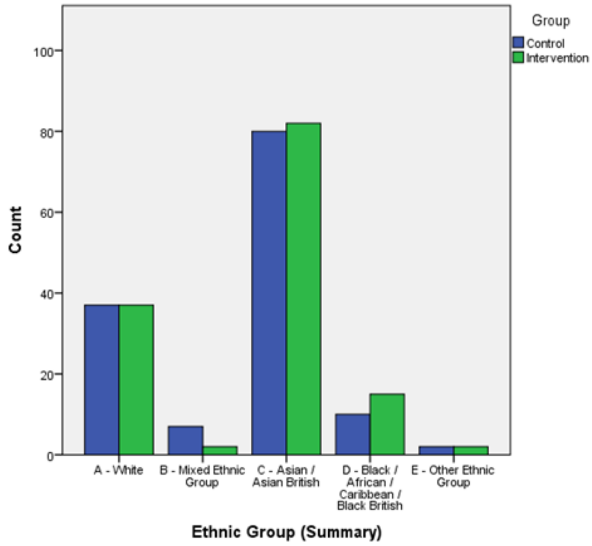
3.4 Demographic analysis

Ethnic Group

The distribution of the two largest ethnic groups (Bangladeshi and White-British) in the energywise project is relatively evenly split across the intervention and control groups, with 154 Bangladeshi (78 in intervention and

76 in control group) and 68 White-British (35 in intervention and 33 in control group) participants across the two groups out of the 278 households that have completed the survey.

Figure 7 is a summary of the distribution of trial participants by ethnic group. As shown in the table below, White British ethnic group is included in category A, while Bangladeshi in category C.



Category	Ethnic group
A	A1 - White British A2 - White Irish A3 - White Gypsy/Traveller A4 - White Other
B	B1 - Mixed - White and Black Caribbean B2 - Mixed - White and Black African B3 - Mixed - White and Asian B4 - Mixed - Other
C	C1 - Asian / Asian British - Indian C2 - Asian / Asian British - Pakastani C3 - Asian / Asian British - Bangladeshi C4 - Asian / Asian British - Chinese C5 - Asian / Asian British - Other
D	D1 - Black / Black British - African D2 - Black / Black British - Caribbean D3 - Black / Black British - Other
E	E1 - Arab E2 - Other ethnic group

Figure 7: Distribution of trial participants by ethnic group

Primary Language

The high proportion of Bangladeshi households is reflected in the high proportion of participant households speaking Bengali as the primary language at home. As with ethnic group, primary language is relatively evenly split across the intervention and control groups. Out of the 278 participants who have completed the survey, 114 identified Bengali as the primary language at home, 119 said English and 25 indicated both English and Bengali (Figure 8). Other primary languages included for example French, Chinese, Somali and Portuguese.

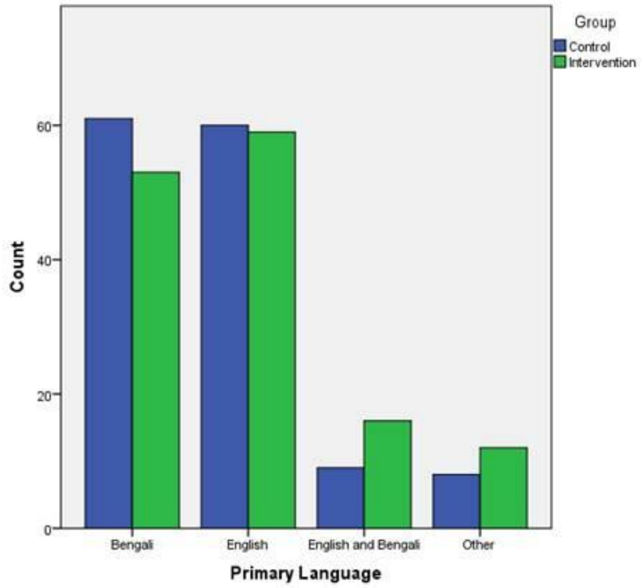


Figure 8: Distribution of trial participants by primary language spoken at home

Household Size

The participants on the **energy**wise project have significantly larger households (mean = 3.53) than the general UK population (mean = 2.38, ONS 2014). The intervention group has a larger average household size than the control group, with more households containing between five and nine individuals in the intervention group while the control group has greater numbers of households of one to four people (Figure 9).

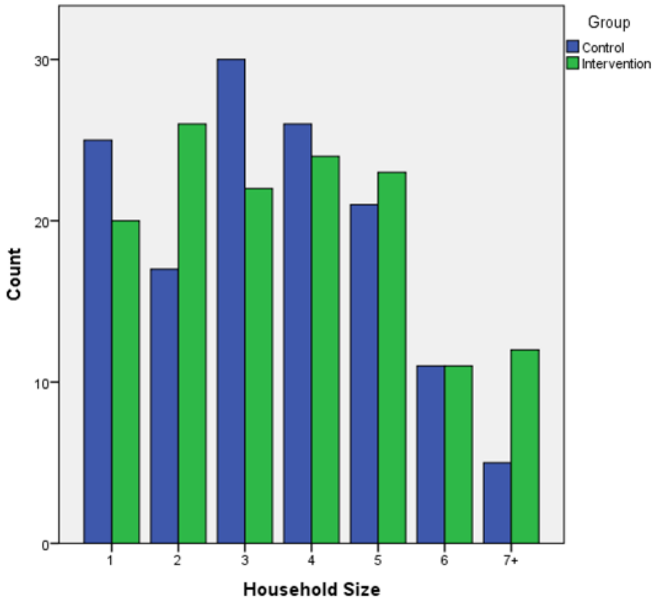


Figure 9: Number of people per household across intervention and control groups

Age

Figure 10 shows the number of households that have one or more residents in each age band. 64% of the 278 participants who completed the survey said that there is at least one member aged between 25 and 44, with an equal representation across intervention and control groups. 76 household (27% of the respondents) have at least one child under five years old, while 57 households have elderly residents. Specifically, 10% of the respondents reported at least one member aged between 65 and 74, while 11% have elderly residents over 75.

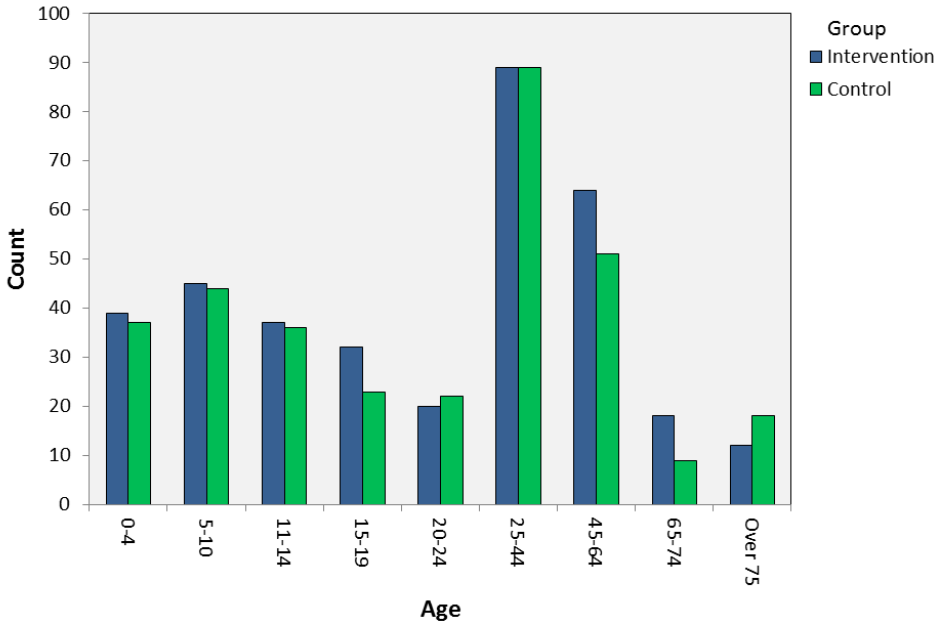


Figure 10: Number of households with one or more residents in each age band

Income

As shown in Figure 11, income is unevenly distributed between the intervention and control groups with the control group having higher numbers of households in the lower income bands (A-B) while the intervention group has more households in the higher income bands (G-L).

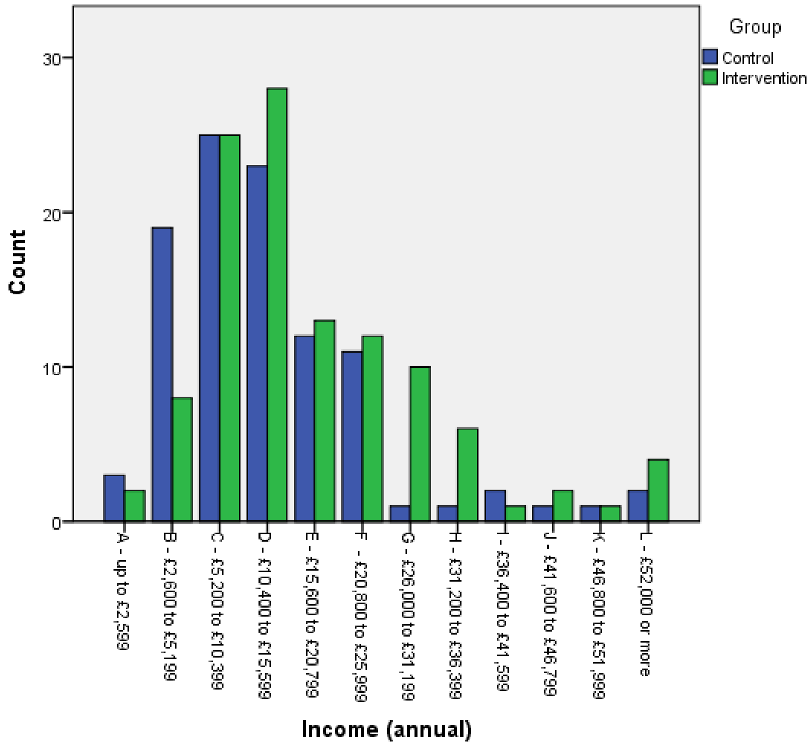


Figure 11: Income distribution across intervention and control groups

Benefits

Figure 12 shows the type of income trial participants are receiving and the proportion of households receiving benefits with an almost even representation across intervention and control groups.. In particular, out of the 278 households who have completed the survey, 154 (82 in intervention and 72 in control groups) reported that they are receiving housing benefits and 130 (66 in intervention and 64 in control groups) are receiving child benefit. Also 47 get income support and 39 are in receipt of other state benefits. The categories are not mutually exclusive, therefore respondents may have indicated more than one category. The 'Other or no source of income' category include 'No source of income', 'Interest from savings', 'Other kinds of regular allowance from outside the household' and 'Other sources (for example rent)'.

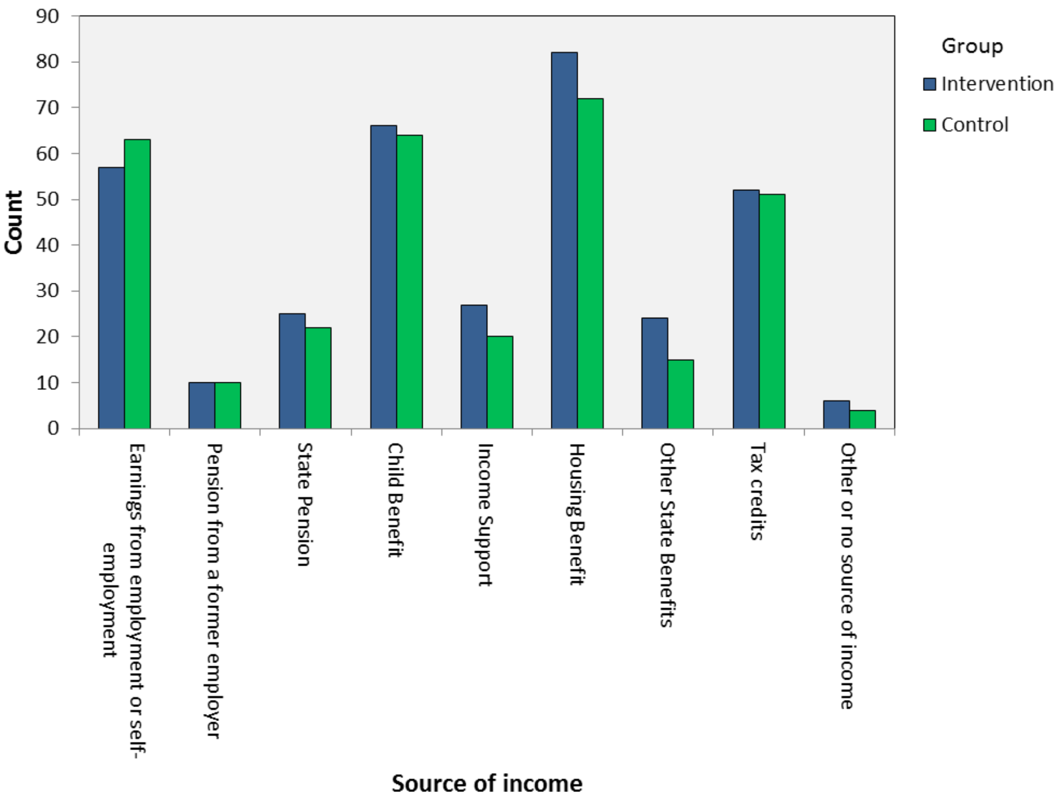


Figure 12: Number of households in receipt of income from each source

3.5 Electricity appliance ownership

As shown in Table 3, the intervention group has a slightly higher level of appliance ownership across the various categories which may merely be a reflection of the higher average household size in the intervention group.

Table 3: Electricity appliance ownership across intervention and control groups

Electricity appliance type	Control group N=138	Intervention group N=140
	Average number of appliances	Average number of appliances
Household size	3.40	3.65
Total Lightbulbs	8.41	8.89
Total TVs	1.52	1.58
Total entertainment devices	2.70	2.79
Total computing devices	1.99	2.19
Total ancillary computing devices (e.g. printers etc)	0.84	0.93
Total mobile chargers	2.70	2.76
Total wet/dry appliances	1.15	1.16
Total cold appliances	1.61	1.64
Total (secondary) electric heaters	0.61	0.59

3.6 Energy Social Capital in the trial area

Introduction to Energy Social Capital (ESC)

Social Capital refers to 1) the social networks, trust and reciprocity of a community (collective social capital) or 2) the resources available in a person's social network (individual social capital). The study undertaken in the **energy**wise 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 2011[10]). 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. Additional insights on trusted networks have been collected through a process of local stakeholder engagement, discussed at the end of this section.

Survey Administration

The ESC survey was mailed to respondents two weeks after they had signed up to the project. To date 526 ESC surveys have been mailed and 209 have been received back, giving a response rate of 39.7%. At the time of writing, from those still active in the trial, University College London received surveys from 179 (92 Control, 87 Intervention), giving a response rate of 50.7%.

Findings

The findings from the surveys indicate some level of information seeking about energy and a fair amount of 'energy social capital'. That is 146 out of the 179 respondents knew people in their social networks to whom they would turn for energy related advice, and 80 respondents (45%) had had a conversation in the last six months related to electricity. Trust varied through the sampled population, with a majority trusting people in the local area, while only 21% trusting people 'in general'.

The findings this far suggest that electricity usage and energy related issues are not a specific or overwhelming concern for this group, but most have social resources they can turn to if there is an issue they'd like to discuss and many use the media or other organisations as sources of information and advice.

Trust

Trust in the local community is high. 63% (113) of the respondents indicated that they trusted people in their area, with 10% (17) of these respondents trusting local people "A lot" (see Figure 14 below). Trust in general is lower than trust in local community. When asked if 'most people can be trusted' only 21% (36) respondents felt this was the case, 34% (60) responded with 'depends', while 42% (74) responded that they felt one 'can't be too careful' (see Figure 13). This is slightly below national levels of general trust as found in the Understanding Society survey from 2009 -2010. In this survey just over a third (35%) of people reported that they would say that most people can be trusted (Siegler, 2015[11]).

[10] 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.

[11] Siegler, V. (2015) "Measuring National Well-Being - An Analysis of Social Capital in the UK." (January):1–36

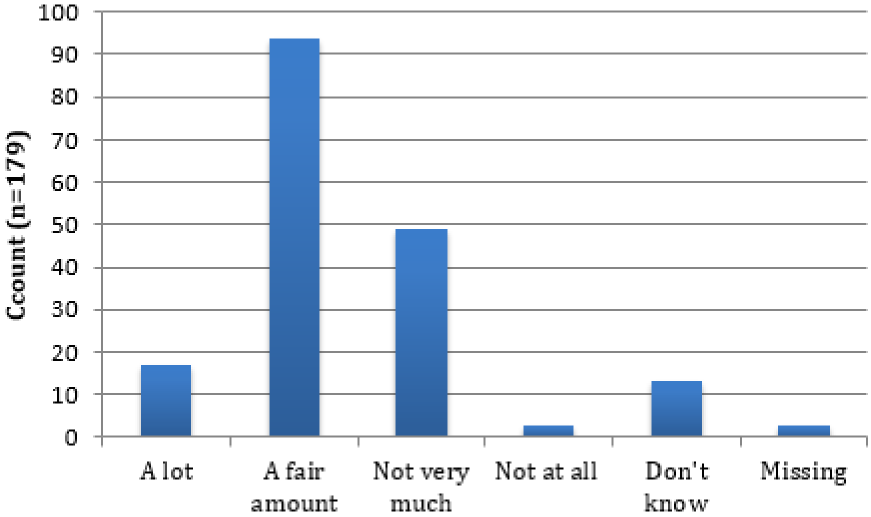


Figure 14: Trust in people in local area

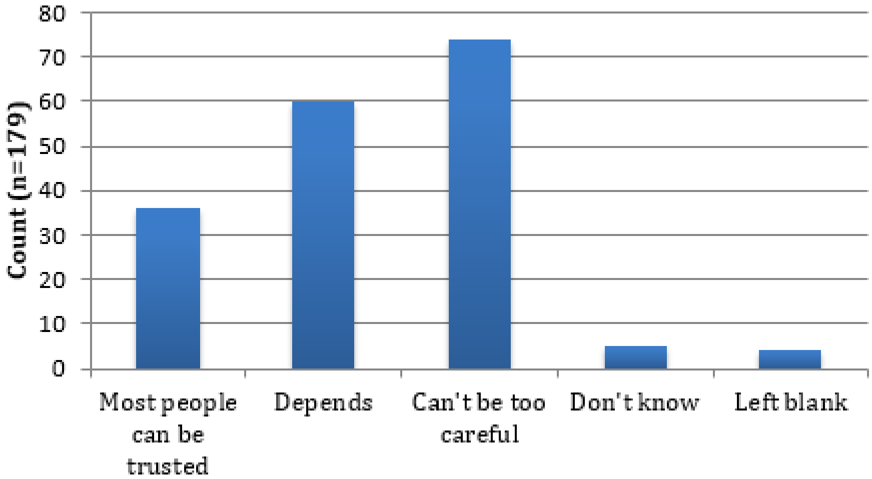


Figure 13: Trust in general

Energy Social Capital Resources Several questions addressed where people look for, or find, information on energy efficiency or household energy use. This addresses 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. Previous research has linked this type of research with higher instances of adoption of energy efficiency devices (see McMichael, 2011[10] & MicMichael & Shipworth, 2013[12]).

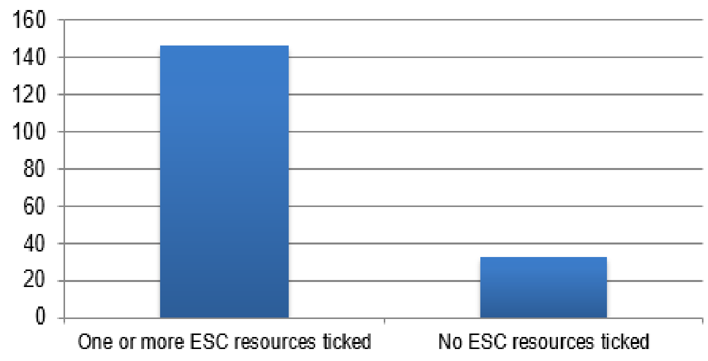


Figure 15: People identified as ESC resources in social network

Participants were asked whether they knew people who they could ask about a range of energy related issues. 18% (33) respondents left this question blank, or ticked no to every question, but 82% (146) were able to identify at least one person they knew to ask for information in one of the areas (see Figure 15).

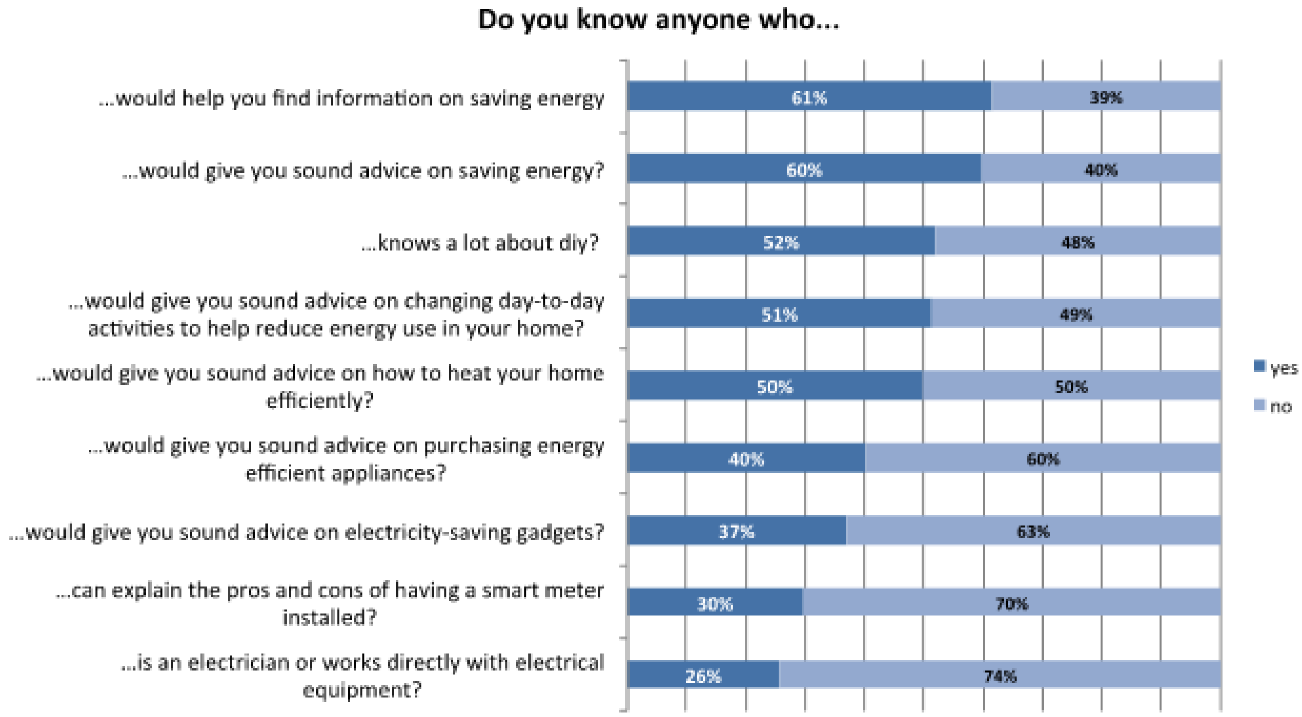


Figure 16: Knowing people who can help with energy use in the home

The highest positive responses related to knowing people who could help save energy; 61% (110) of respondents knew someone who could help them to find information on saving energy, and 60% (107) of respondents knew someone who would give them sound advice on saving energy (see Figure 16).

12 McMichael, M. and D. Shipworth (2013) "The value of social networks in the diffusion of energy-efficiency innovations in UK households." Energy Policy 53: 159-168

Respondents were asked to specify whom within their social networks they could turn to for advice or information on energy use in the home. They could tick as many types of people out of 'Family, Friend, Neighbour, Workmate, Acquaintance or Other'. Figure 17 shows that the majority of energy social capital resources are within the family. Without exception family members made up the biggest group of people who could be asked about any issue, followed by friends.

Interestingly it is only in the case of learning about smart meters that a third category of person becomes an equally important source of information. 21 respondents identified 'Other' in response to this question, while family members were identified by 25 respondents and friends by only 17. This means that this population has fewer energy social capital resources for helping them understand smart meters may be further removed from their immediate social networks.

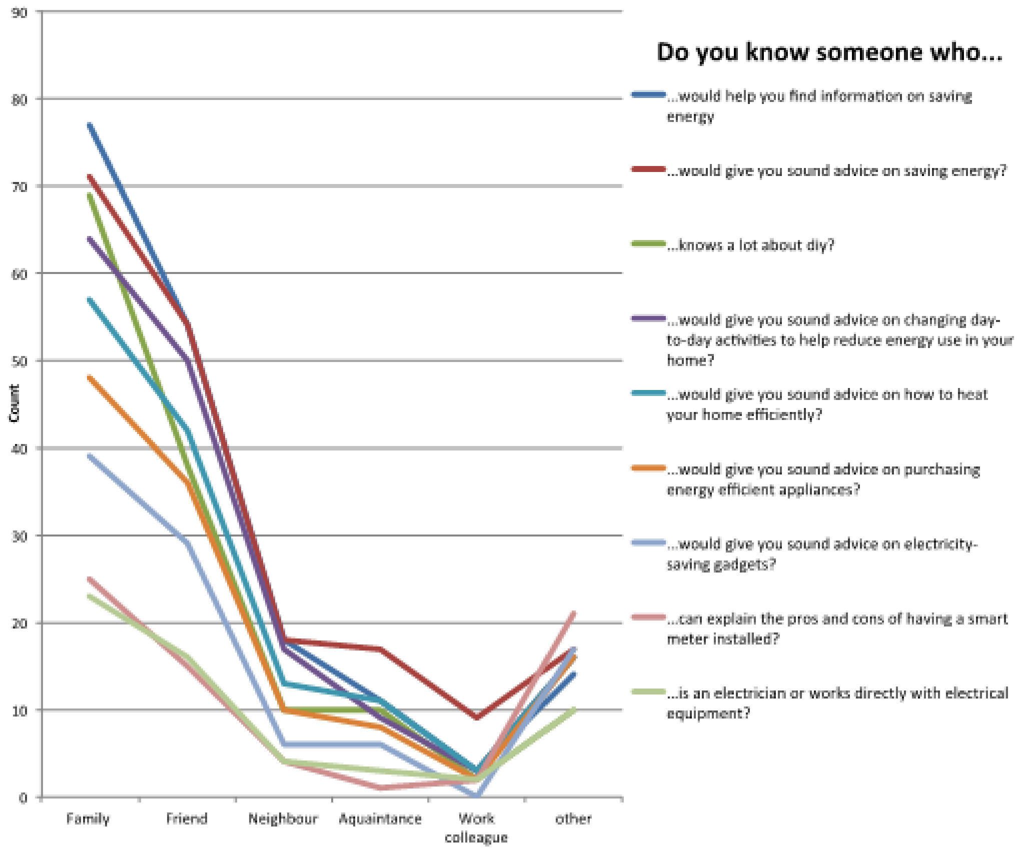


Figure 17: Sources of help and advice on energy

<u>Finding Information</u>

The survey also identified how people 'operationalise' (or put in use) their ESC. Respondents were asked to think whether they'd discussed electricity with people they know in the past 6 months. 45% (80) had had a conversation with one or more people they know in the last 6 months about electricity, while 45% (81) had not spoken about electricity in the past 6 months (Figure 18). This suggests electricity is not a major source of concern or interest for the sampled population.

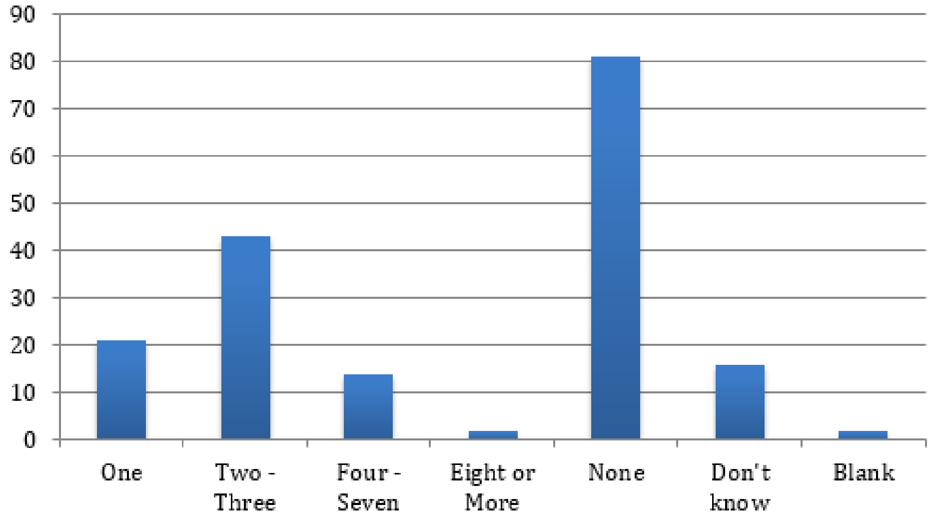


Figure 18: Conversations about electricity in the past 6 months

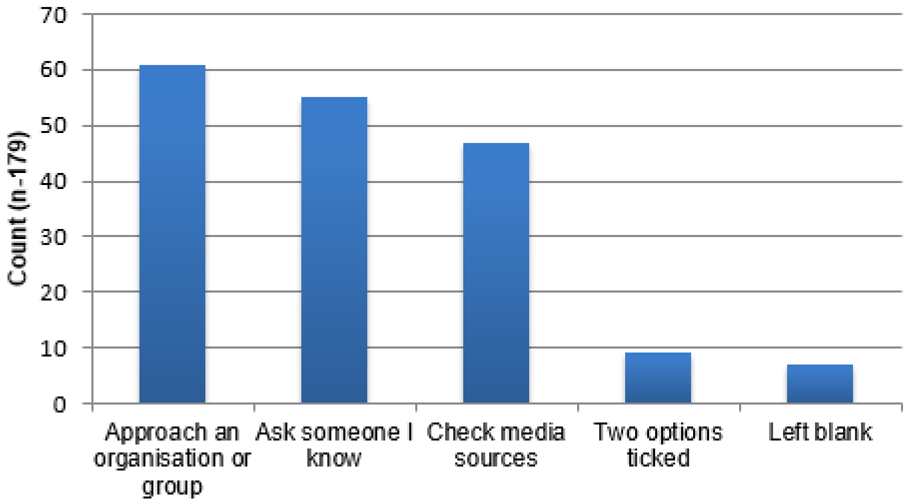


Figure 19: The first people would go for information in the future

Respondents were also asked what would be the first thing they would do if they had a question on electricity in their home, 34% (60) said they would ask someone they know, 29% (52) said they would check media sources and 37% (66) said they would approach an organisation or group (see Figure 19). This suggests that although this population recognise their family as a source of information and advice on energy, individual respondents are more likely to turn to resources outside of their social networks rather than turn to their family when looking for information.

Furthermore, when asked whether they actively sought information about electricity and energy efficiency, only 13% (23) respondents said they did, while 21% responded that they 'don't get tips or advice' (see Figure 20). 21% (37) respondents said they found information by chance, while 33% (59) felt they received information through a mix of chance and by actively searching for it (see Figure 20). This means that the majority of respondents are getting information or advice about electricity or energy efficiency, but only a minority are actively pursuing this information. This can be interpreted positively for the project because even when people receive information passively about electricity they still recognise this information source. Therefore the introduction of a feedback device such as an in home display connected to a smart meter may be recognised as a useful source of information about managing electricity in the home, even though the participant has not actively been seeking this type of information.

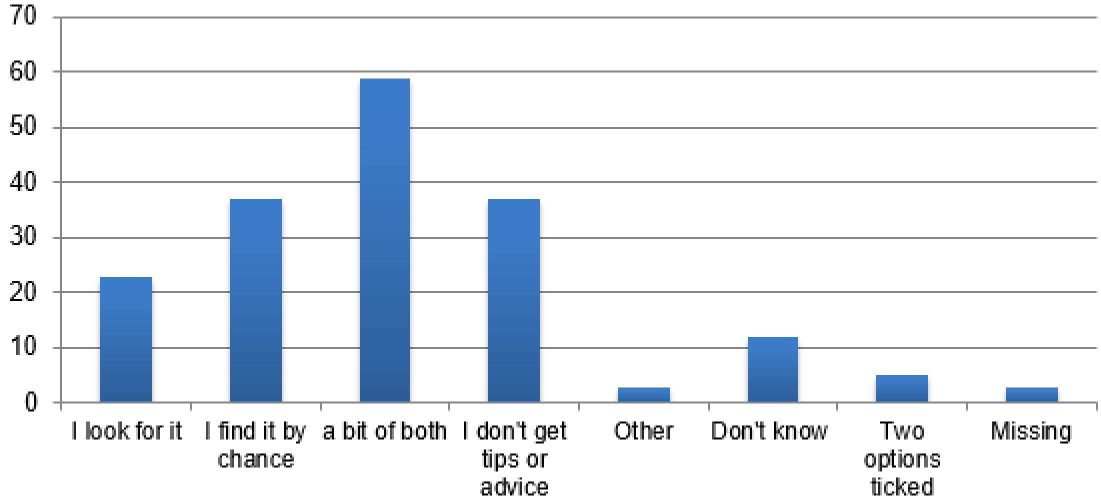


Figure 20: Active information seeking

Energy Social Capital and primary language spoken at home

By compiling the data provided by participants for the HES, it is possible to understand how ESC varies according to the primary language spoken at home. University College London has received HES for 149 of the participants who returned their ESC survey. Of these three chose not provide their ethnic group, but only one chose not to answer the question about the primary language spoken at home. Therefore language information correlated to ESC information is available for 148 of Trial 1 respondents.

In the results that follow these respondents are divided into four groups based on primary language; English (73 households), Bengali (54 households), Joint English & Bengali (14 households), and 'Other' which includes one Portuguese speaking household, one Chinese speaking household and five households which marked 'Other'.

Trust

This information shows that local levels of trust are higher for households who have Bengali as their primary language (Figure 21)

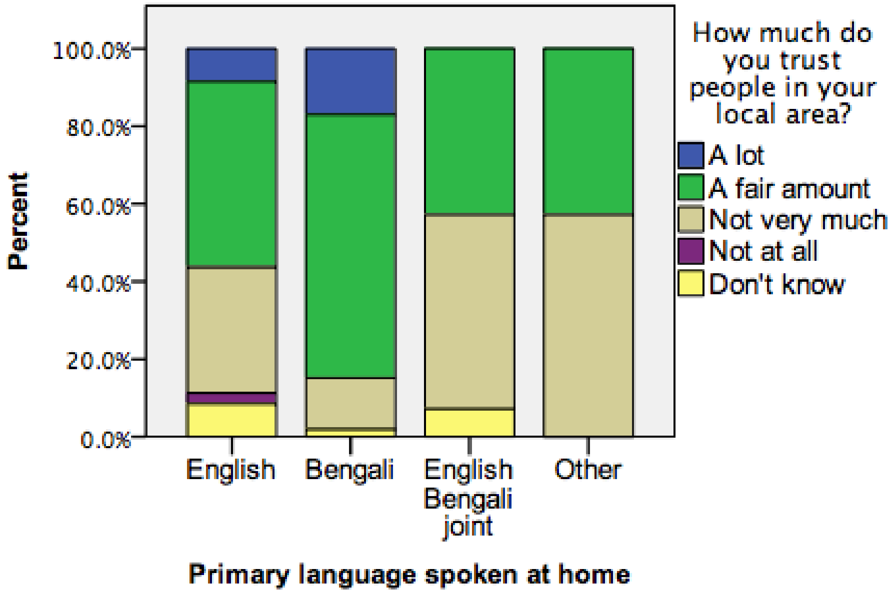


Figure 21: Local trust by language group

This distinction is not as large when looking at generalised levels of trust as shown in Figure 22 below.

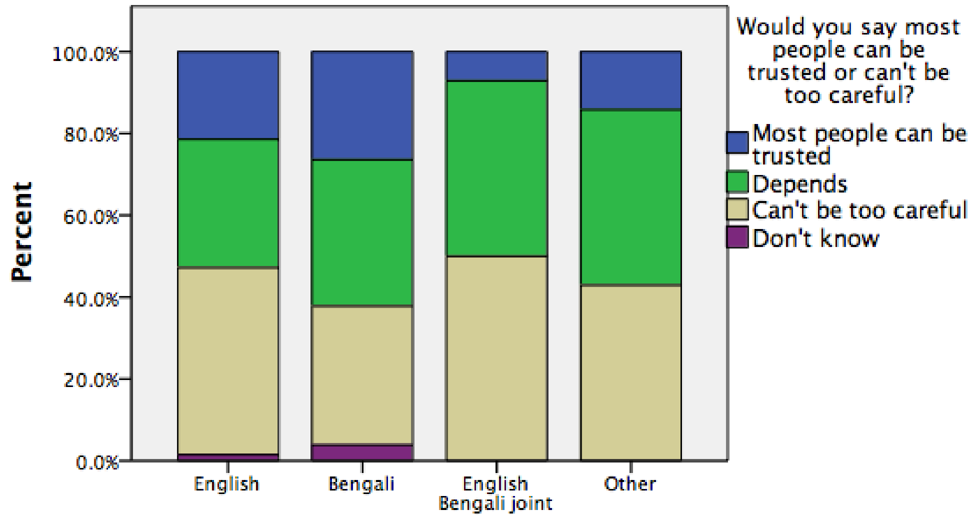


Figure 22: General trust by language group

Information seeking

Members of Bengali speaking households are more active in seeking information about electricity and energy advice. The overall split between those who receive information actively, passively and through a combination in comparison with those who feel they do not receive information is broadly similar across language groups, with between 66% and 57% feeling that they do get some information (Figure 23).

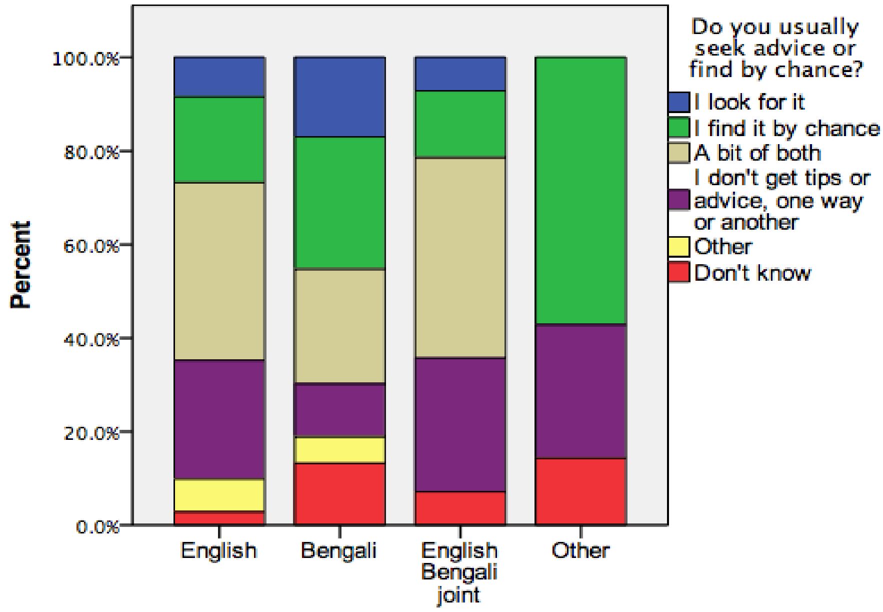


Figure 23: Information seeking by language group

The sources used to find information differ slightly with English language households more likely to approach an organisation, Bengali Language households more likely to ask someone they know and joint Bengali and English language households more likely to use the media (Figure 24).

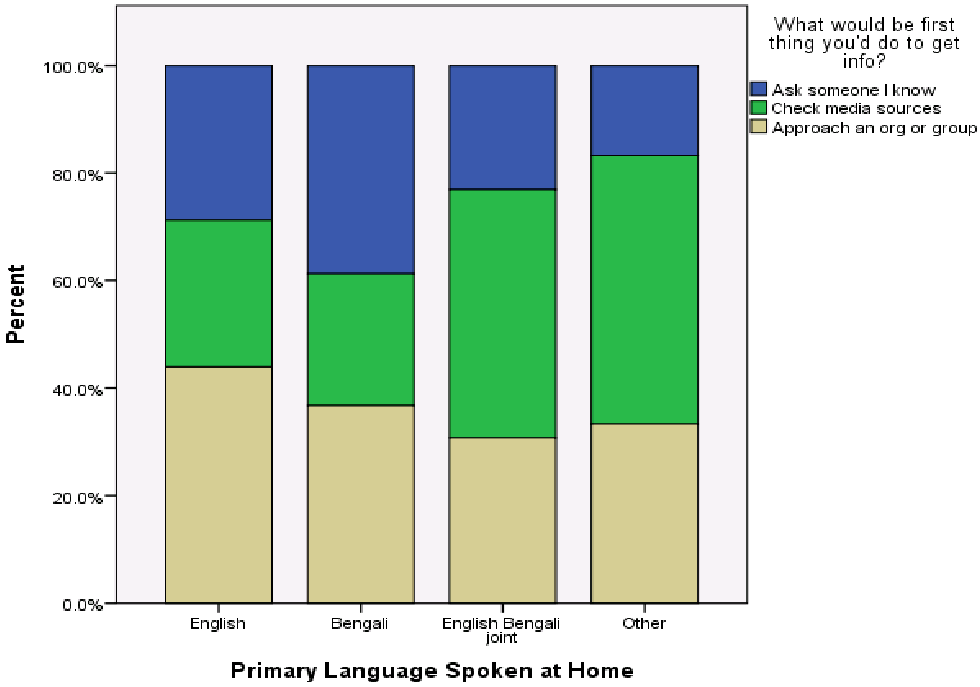


Figure 24: Sources of information used by language group

More analysis is needed to understand these variations particularly to examine the relationship between language group, household income and household demographic structure to establish if these explain some of the variation observed.

Engaging with stakeholder organisations

Organisations and institutions can contribute to a household's ESC if they are recognised as trusted sources of relevant information. The research was designed to firstly identify local organisations that might fulfil this role and secondly to activate this form of ESC through a process of engagement. The stakeholder engagement process was designed to understand the local organisations that participants turn to for advice as well as to provide additional support for the project by ensuring the key project messages were circulated amongst local organisations.

As part of the trial design local organisations were identified and categorised to provide a ranked set of stakeholders that might be recognised as trusted sources of information by the research participants. The process of engaging these stakeholders was initiated prior to the recruitment phase of the trial, but was suspended as the recruitment process required the project team members to concentrate all resources on recruiting participants. The stakeholder engagement process was reinstated and completed following the recruitment phase.

The rationale for continuing with the process of stakeholder engagement beyond the planned pre-recruitment phase was that local organisations can continue to support the project if they are aware of the objectives and the outcomes for any participant involved. They can relay key messages and raise confidence in the project should participants turn to them to discuss concerns about their involvement.

In addition, through a process of ongoing engagement, stakeholders can provide a valuable feedback loop and may provide some insight into participant concerns and annoyances. This will help project partners to reflect on project processes and improve the research experience for participants, while also enabling the research team to gain more insight into how ESC functions within the trial population.

Following the decision to restart contact, the list of stakeholders was reviewed with Bromley by Bow Centre staff and reprioritised using the criteria adopted in the original mapping exercise (expertise, willingness and value) but updated with new categories, reflecting Bromley by Bow Centre staff insight on the roles of the organisations. The contact process restarted on 17 November 2015. In total attempts were made to contact 22 organisations, but 13 were not contactable. Of those reached, two had heard of the project through word of mouth. They did not know any specific details and did not provide any feedback, but did show that there is at least a very low level of talk about the project.

When contacted, all organisations were given the key messages about the project and asked if they could be contacted again in the future, all bar two agreed. These organisations will be emailed at the start of Trial 2 in order for the next stage of the project to be explained and to ask for any feedback about **energy**wise if they've heard from their service users about it.

4. Trial 1

Trial 1 is the first of the two **energy**wise trials conducted within Tower Hamlets and it focuses on energy saving. The aim of Trial 1 is to identify the magnitude of energy savings and the impact on the electricity network when customers have access to smart metering solutions, simple affordable energy saving devices and energy saving advice.

As described in Section 2.2, the trial has an intervention and a control group, with random allocation of participants between groups. A package of interventions (see Section 4.2) has been provided to an 'intervention group' against a 'control group' that does not have access to them, as per the requirements of a randomised control trial. Therefore, the effect of the trial will be quantified through comparing findings from the intervention group to the control group. Please note that 'control' group does not mean controlled to have similar level of consumption or household size, and similar criteria, as we will see later. As such, some adjustments are required when making the comparison.

4.1 What has happened so far

A 'feathered-in' approach was adopted for Trial 1: instead of having all trial participants entering in Trial 1 on the same date, the individual start date of Trial 1 is defined as the date of the first reading received from the monitoring equipment. This reflects the participants' experience, as it is the installation of the smart meter, and provision of the in home display, that provides the participant with the capacity to learn about and respond to feedback on their energy use.

As shown in Figure 25, some households in the intervention group of Trial 1 started back in May 2015 with the first installation being completed on 20 May 2015. Control group participants have generally started the trial from August onwards when a technical solution was determined to resolve the space constraint challenge of the secondary electricity meter installation in the meter cabinet.

The 'feathered-in' approach enabled further extension of the installation phase and a more accurate data analysis that will now be able to capture the behavioural change expected immediately after installation in the intervention group. It is worth nothing that this approach potentially introduces some seasonal variability effects (i.e. since certain months will now be monitored in 2016 for some households and 2017 for other households in the trial and the prevailing weather conditions in those months may differ from year to year). Corrections in the data analysis may be required to take into account these potential effects of the different start dates.

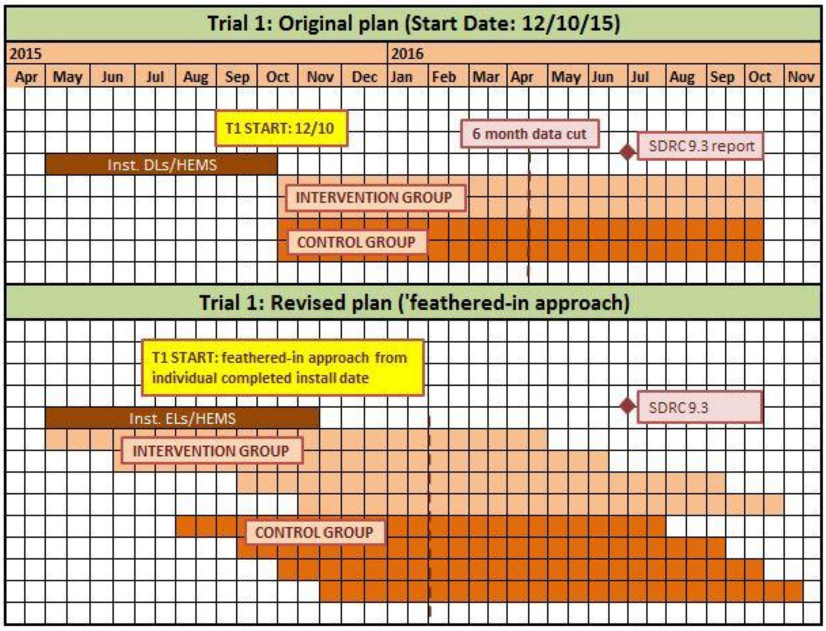


Figure 25: Trial 1 plan

As each installation was completed, the data from their smart meter began to be gathered on a daily basis in a repository at British Gas (see lesson learnt L7.4 in Section 9.7 for half hourly meter reads). British Gas pass a cut of the available data to the analysis partners University College London and Element Energy, on a regular basis. The analysis presented in this report is focusing on the daily data received as of 31 January 2016 (see Section 5.1.2). A full set of 12 months of data will be available from all of these customers by December 2016, when an update to this report is scheduled to be published.

4.2 Trial 1 interventions

Trial 1 interventions have been provided to active participants during the installation phase of the project depending on their group allocation as per to the research trial design presented in the SDRC 9.1 report.

The project began installations at the end of May 2015 at households who had signed-up within the pilot study and the installation work was then continued with main trial participants. An issue was identified where several technical aborts were registered within control group due to space constraints for the installation of the secondary electricity meter in the meter cabinet: in fact for control group households within building category B (the building type which the majority of the projects' eligible households reside within) the meter cabinet containing the current meter and consumer unit had insufficient space for the secondary electricity meter to be mounted. Two different solutions have been implemented depending on the meter type:

- **Credit customers in control group:** a credit smart meter was installed (including a gas smart meter for dual fuel customers) but the smart energy display was not commissioned; the smart meter would simply work as electricity monitoring equipment, while no customer engagement will be 'activated' until Trial 2 when the smart energy display will be delivered to control group participants.

- **Prepayment customers in control group:** as some key prepayment functionalities are not accessible for prepayment customers if a prepayment smart meter is installed without the smart energy display, a different solution has been implemented for prepayment customers in the control group. This is in the form of a device called Navetas electric loop being installed by the British Gas's subcontractor, Passiv Systems (as confirmed on 11 September 2015). As an electric loop consists of a clamp connected to the standard meter and does not require additional secondary units to be installed in the meter cabinet, this technical solution was proven to be successful in the resolution of any space challenge (See Figure 26).

Figure 26 - Navetas electric loop equipment

Figure 27: Energy efficiency devices & energy efficiency advice leaflet

Table 4 provides an overview of the interventions of Trial 1: the intervention package provided during the installation phase included mainly the smart metering solution with the smart energy display, the British Gas Smart Energy Expert's installation visit including the British Gas energy efficiency booklet, the energy saving devices delivered by the CFO and the energy efficiency advice leaflet developed by the project (Figure 27).

The research design envisaged that the energy efficiency devices and the energy efficiency advice leaflet would be delivered during the smart meter installation. However, it was not always possible for the CFO team to visit the property at the same time as the Smart Energy Expert. Therefore, the devices and leaflet were often delivered at a different time and required an extra appointment to be arranged with the household.

Table 4: Overview of interventions and non-interventions provided in Trial 1 to intervention and control group

Interventions	Trial 1			
	Intervention group (group 1)		Control group (group 2)	
	Credit	**Prepayment**	**Credit**	**Prepayment**
Electricity smart meter	Credit smart	PP smart	See below	-
Gas smart meter	Credit smart[13]	PP smart[13]	See below	-
Smart energy displays	Credit smart	PP smart	-	-
British Gas Smart Energy Expert	Yes	Yes	See below	-
Energy efficiency booklet	Yes	Yes	-	-
Energy saving devices (three LED lightbulbs, one eco-kettle and one standby shutdown)	Yes	Yes	-	-
Energy shifting devices	N/A	N/A	N/A	N/A
Advice on energy efficiency & energy saving devices	Yes	Yes	-	-
CFO electricity efficiency advice	Yes	Yes	[14]	[14]
Newsletters	Yes (Not yet)	Yes (Not yet)	-	-
Stakeholder support	Yes	Yes	-	-
Dissemination events[15]	Yes (Not yet)	Yes (Not yet)	-	-
Non-interventions				
Referrals by CFO to further information	Yes	Yes	Yes	Yes
Temperature monitoring equipment	Yes	Yes	Yes	Yes
Electricity smart meter (without smart energy display)	-	-	Yes (apart from 2 households)	-
Gas smart meter (without smart energy display)	-	-	Yes[16] (apart from 2 households)	-
Passiv ICM 300 secondary meter	-	-	2 households only	-
Navetas loop monitor	-	-	-	Yes
British Gas Smart Energy Expert	-	-	Only as installer	-

[13] Gas smart meters only constitute part of the trial due to the business as usual smart meter rollout at dual-fuel customers who will receive both an electric and gas smart meter as part of the standard customer journey. It is envisaged that this strategy will have positive effects related to the replication point of view.
Please note, eight households in intervention group (two credit and six prepayment customers) have only electricity supplied by British Gas, therefore they did not received a gas smart meter installation.

[14] Please note, if a control group participant asks for energy efficiency advice, the CFO will refer them to standard sources of energy efficiency information.

[15] In addition to dissemination events, some participants will attend participant panels. These are not considered part of the intervention in the trial, as it is not envisaged that they will apply to all participants or would be replicated by other DNOs under the replication model.

[16] Please note, two households in control group (both credit customers) have only electricity supplied by British Gas, therefore they did not receive a gas smart meter installation.

All installations for the control group as well as installations of the standard smart metering solution for the intervention group (apart from those in Padstow House) were completed by PassivSystems by 5 November and by British gas by 16 November 2015, while the delivery of the energy efficiency devices was completed by 25 January 2016 (apart from those in Padstow House and one outstanding household that has not received the three LED light bulbs yet due to the customer being unreachable).

Installations in Padstow House (see Figure 28) were completed on 19 May 2016 following the installation of the MDU Communication Backbone supplied by Siemens in the preceding days. Once the installation by Siemens was complete, smart meters with Smart Energy Displays and the temperature monitoring equipment have been installed by British Gas and PassivSystems respectively on 19 May. During the home visit the customer field officer has delivered all four sets of energy efficiency devices together with the energy efficiency advice leaflet and has administered the four home energy surveys, of which two were completed at that time and two were left for self-completion following the customer's request.

Figure 28: Padstow House

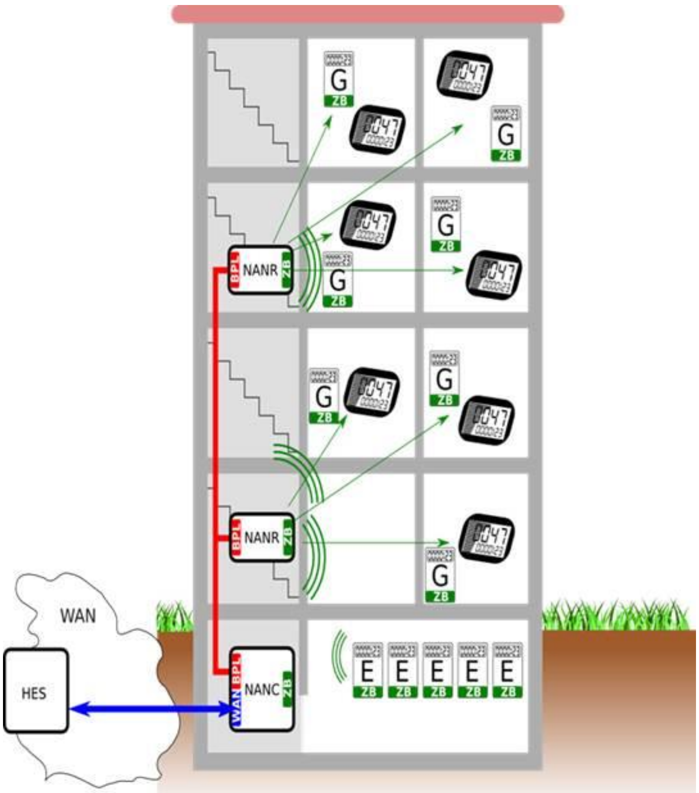


Figure 29: MDU communications backbone

Out of the four households that received their equipment in May, two required the MDU infrastructure to be able to benefit from the smart metering solution. Both meter sets were fully commissioned and communicating with the Smart Home Display in operation in the customers' homes. All meters are returning both daily and half hourly readings. The innovative MDU Communication Backbone (see Figure 29) supplied by Siemens for tall and difficult building was therefore proven successful with both smart meters operating on the extended HAN network, resulting in the UK's first end to end installation of residential smart meter sets operating across a Multi Dwelling Unit/tall and difficult building solution.

Given the differences between installation dates and delivery dates of the energy efficiency devices and energy efficiency advice leaflet, the project partners agreed to use the date of the first smart meter readings coming through as the start date for each individual household. This is because, from the participant's perspective, the receipt of the smart energy display and the interaction with the British Gas Smart Energy Expert constitutes what is likely to be the single largest intervention in energy savings terms.

5. Customer insights

5.1 Electricity data

5.1.1 An introduction to the electricity data (daily and half hourly data)

As discussed in Section 4.2, British Gas installed smart meters into credit and prepayment intervention group customer properties, and credit smart meters into control group customer properties. Intervention group customers received a full smart metering installation including smart energy display with meters configured to return daily and half hourly meter readings each day. Credit control group customers received a smart meter installation without any smart energy display but with the meter configured to return daily and half hourly meter readings each day. The energy consumption for prepayment control group customers is collected via the Navetas loop monitoring equipment, as the project was unable to install prepayment smart meters without a smart energy display. The loop monitoring equipment is also configured to return half hourly readings intervals.

When the meter is able to return the daily and half hourly data, this data is stored in the British Gas reading repository. From here, on the fifth day of each month, to allow for delayed/missing readings to be returned, the data for the previous month is extracted from the read repository. These readings are then processed using the “Check Supplier Data” process outlined in Section 5.1.2. From here the daily and half hourly monthly reading files are zipped, encrypted, and sent to University College London via the secure files transfer systems for project analysis. The consumption data for loop monitoring equipment is supplied to British Gas by Navetas on the fifth of each month. Navetas use a secure internet gateway that connects the loop monitoring equipment to a secure web platform. The energy consumption data from the loop monitoring equipment is transferred to this platform via a broadband or GSM internet connection. British Gas will then run the “Check Supplier Data” process and transfer the files to University College London using the agreed secure project data transfer methods outlined above.

5.1.2 Data quality and data accuracy checks

British Gas Check Supplier Data processes

There is a ‘Check Supplier Data’ process intended for British Gas to run some pre-checks, data cleansing, and validation on the smart meter and temperature monitoring reading data supplied to University College London as there may otherwise be a delay until University College London identifies any data issues.

The first step of the check supplier data process is data cleansing. British Gas ensure there are no duplicate readings contained within the data sets and that the most recent and fulfilled data sets are supplied (deleting others). The data is then validated at a customer level and fulfilment reports are created for each data file, each month, detailing the data start date, data end date, and data fulfilment in number of days and percentages.

University College London Data Quality/Quality Assurance processes

A key objective of the quality assurance process for **energy**wise data is to ensure that both the quantity and quality of data available for analyses is maximised. Both quantity and quality of data are important as they have substantial impacts on the level of statistical confidence in findings. Table 5 summarises the electricity data available for the 6 months data analysis presented in this report.

The installation of smart meters was staggered from May to November 2015 with a low number of installations in the early months skewed towards the intervention group. To reduce the impact of this unbalance and the impact of a changing sample size from month to month, the analyses for this report have used a 6 month cut of data (August 2015 to January 2016).

Table 5: Summary of electricity data

Meter type	Readings	Available data as of 31 January 2016
Smart meter	Daily Reads	• University College London have received smart meter data (daily reads) for 284 participants • 12 participants have subsequently dropped out of the project and their data has been excluded from this report • University College London have received 41,436 daily read records • The fulfilment rate (valid daily reads received/possible daily reads) for participants with data is 93.2%
	Half-Hourly Reads	• Due to issues with the installation of some smart meters (see Section 9.7 for more detail), at the time of writing University College London have received half-hourly data for only 90 participants • Three participants have subsequently dropped out of the project • University College London have received 662,179 half-hourly read records • The fulfilment rate (HH reads received/possible HH reads) for these 87 participants is 97.5%
Navetas electric loops	Half-Hourly Reads	• Approximately 60 participants (prepayment customers in the control group) have their electricity consumption recorded by Navetas Loop Sensors • This data was not available for inclusion in the analyses for this report[17]
ICM300 secondary meters	Half-Hourly Reads	• Two participants (credit customers in the control group) have their electricity consumption recorded by ICM300 Secondary Meters • This data was not included in the analyses for this report.[18]

The First Read date represents the date that the smart meter was fully up and running (commissioned) and the first point at which analyses of electricity consumption can begin. Table 6 shows the number of participants whose smart meters were commissioned (became “active”) by month.

Table 6: Number of participants whose smart meters were commissioned (became “active”) by month

Month	First Reads	Cumulative
May	10	10
June	19	29
July	74	103
August	39	142
September	80	222
October	56	278
November	6	284
Total	**284**	

The University College London data quality processes applied to the data for this report include basic checks to ensure that files match relevant data specifications, checks for duplicate records, checks for missing data, tests on the distribution of missing data, checks for erroneous or suspect values (e.g. extreme outliers), tests for suspected meter faults, and the creation of various data quality variables.

[17] Given the time required to develop an alternative solution to the secondary meters due to space constraints, the Navetas loops were mainly part of the latter batches of installations. This data were not fully available at the time of the analysis for this report, but will be included in the 12 month view of the energy saving trial.
[18] This data will be included in the 12 month view of the energy saving trial.

A detailed list of University College London data quality processes is provided in Appendix A. As more data becomes available, these processes will likely be revised and additional processes (e.g. checks for vacant properties and processes to interpolate missing data) are likely to be included which may change the underlying datasets available for analyses. The data processes listed in Appendix A apply to smart meter data (daily reads) eligible for inclusion in this report only.

5.2 Quantitative analysis

Analyses of electricity consumption (via smart meter data) is the primary channel for investigating any energy saving resulting from the interventions provided to the intervention group. Electricity consumption in the intervention group is typically compared to consumption in the control group (who did not receive the intervention measures). In subsequent reports the project will also analyse electricity consumption across a range of other variables (e.g. household size, appliance ownership, fuel poverty indicators etc.) when more data becomes available.

In order to maximise the use of the data available for this report while maintaining data quality and minimising potential skews in the dataset, the following filters were applied to the smart meter (electricity) dataset:

- Smart meter readings between 1 August 2015 and 31 January 2016 were used. January data was the last monthly dataset available for inclusion in this report. May to July 2015 data was excluded as only a relatively small number of records were available with a significant skew to towards the Intervention group resulting from the pre-trial installation schedule;
- Any data from participants who had dropped out of the project before 1 February 2016 was excluded from analyses;
- Only daily (rather than half-hourly) smart meter readings were used for the quantitative analysis of the energy savings;
- Credit customers were included in these analyses and pre-payment customers were excluded. This is because data for pre-payment customers in the control group was not available for the analysis as of the 31 January 2016;
- Only valid daily meter reads were included. A valid read (for this report) is defined as a read with an effective time of 23.59.59 and 24 hours since the previous read. This ensures that readings for partial days or multiple days are excluded for this analysis; and
- Data from meters where there is clear evidence of a meter fault were excluded. This has resulted in data from 1 meter to be excluded from this report.

This resulted in a total of 29,657 daily smart meter records from 211 participants being available for inclusion in analysis of smart meter data for this report.

<u>Description of the difference between energy use of intervention and control groups</u>

When comparing the energy consumption between the two within-trial groups, it appears that the intervention group has higher average energy consumption than the control group. This difference in consumption is seen in the pre-trial Estimated Annual Consumption (EAC) data and continues in the monthly electricity data available to this report. The difference in energy consumption is statistically significant at the 0.25 level used in the design of the trial (T-test for equality of means, sig = .217). Expressed more simply, this is like saying that the chances of this happening purely by chance are around 22%, or the same as correctly guessing the outcome of a roll of a five-sided dice. Even though the chance of this happening by chance are low, the project believes that the difference in energy consumption between the two groups has raised purely by chance, because of chance differences in household size between the groups. The project believes that this may have happened given how similar the groups are across the other factors taken into consideration.

The higher consumption in the intervention group is potentially related to the difference in average household size between the groups, with the intervention group having significantly larger households (T-test for equality of means, sig = .075).

Table 7: Differences in average household size between groups when considering only credit customers with smart meter data vs all participants

	Mean Household Size		
	Intervention Group	**Control Group**	**Difference %**
Credit customers with smart meter data	4.2	3.7	13.5%
All participants	3.6	3.4	5.9%

Table 7 shows the household size per group for credit customers with smart meter data versus al participants who have returned the HES. It is worth noting that the difference in household size between intervention and control groups is greater for the dataset with combined HES and smart meter data than for the dataset with just HES data (as Table 7). However the analysis in this section requires the use of the combined dataset even though the difference in household size is greater. Again, it appears that the increased skew in the combined dataset appears to have occurred by chance i.e. credit customers with smart meter data used for this analyses happen to have an increased difference in household size than the dataset based solely on the HES.

The skew in household size can be seen in Figure 30 with the control group have greater numbers of 1, 3 and 4 person households and the intervention group having more 5 to 9 person households.

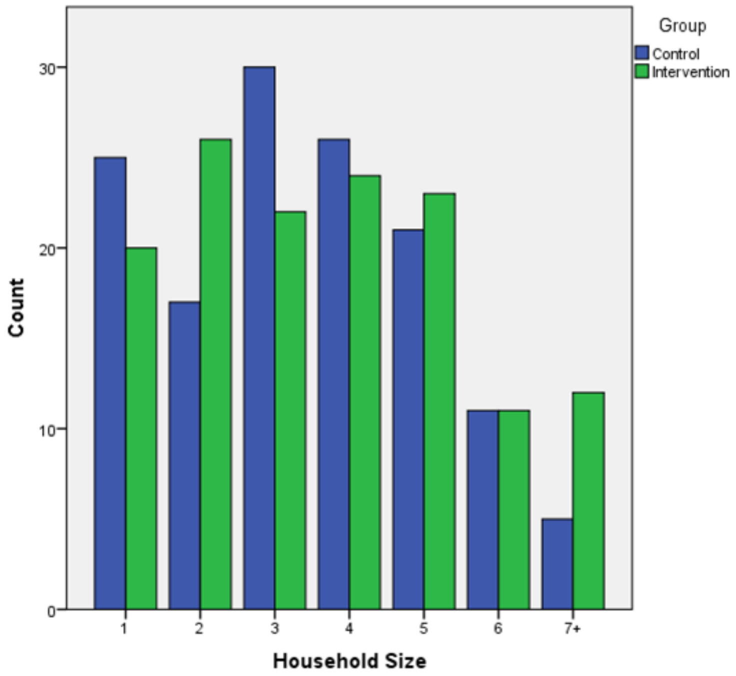


Figure 30: Number (count) of households by household size

The impact on energy consumption of higher numbers of larger households that are found in the intervention group compared to the control group is highlighted in Figure 31.

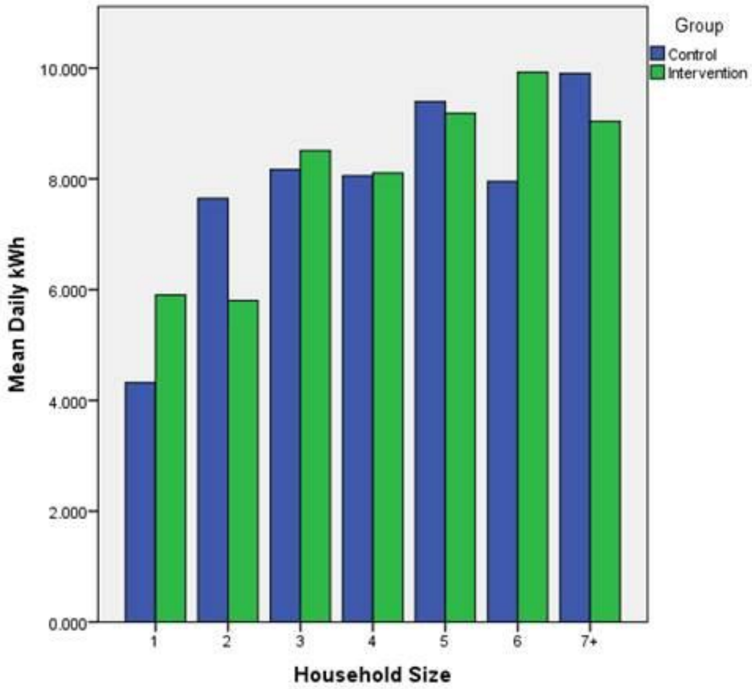


Figure 31: Average daily kWh by household size

The impact of the difference in energy consumption and household size between the control and intervention groups will be investigated in more detail in subsequent reports.

5.3 Trial 1 energy savings

The analysis presented here based on 6 months of data has found no statistically significant evidence of energy saving in Trial 1 (with the limited dataset available for this report). However, with more data available and refined analytical methods, it is entirely possible that future reports will find evidence of energy saving.

As shown in the graph below (Figure 32) there is a large range in average daily household electricity consumption across months and groups which make it difficult to draw any firm conclusions regarding energy savings in this report. The variability in energy consumption and the variability of the variability (across months and groups) will be investigated in subsequent reports as more data becomes available.

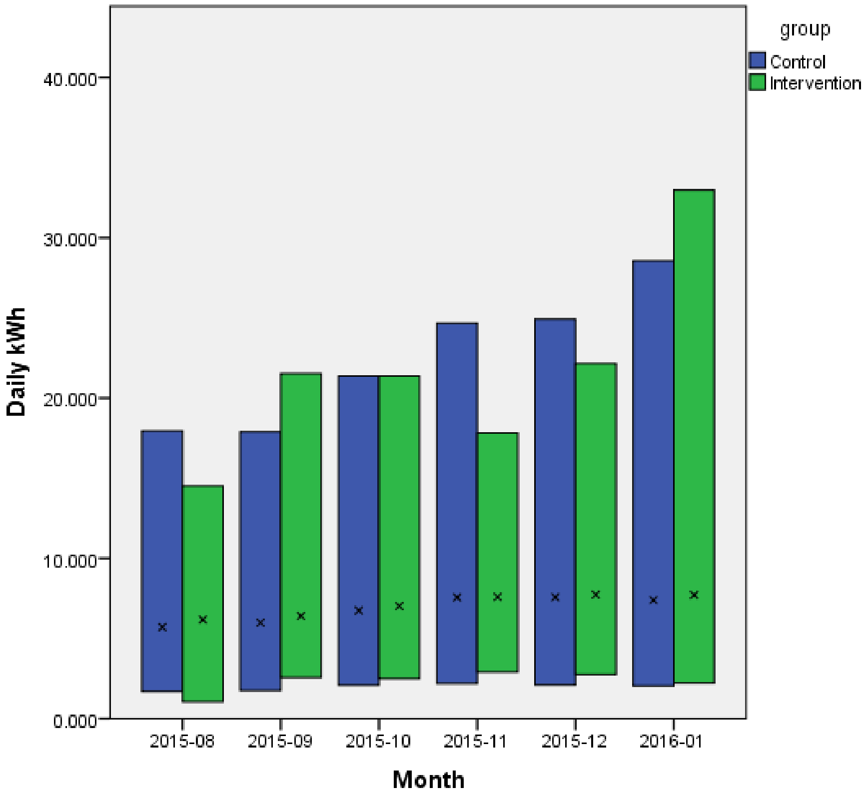


Figure 32: The range and median daily kWh by month. x = Median daily kWh.

As can be seen in Figure 33, the analysis undertaken so far provides no robust evidence of greater energy saving in the intervention group compared to the control group. The seasonal impact of increased energy consumption in winter months is broadly similar in both groups. Further investigation and analyses in subsequent reports may provide different results regarding energy saving in Trial 1.

Furthermore, preliminary analysis has shown that correcting for the household occupancy level of each household and their estimated annual consumption from the year prior to the trial (see Section 5.2) did not yield a statistically significant saving between the intervention and control groups with the data currently available. As such, further analysis of the impact of these factors will be conducted when the full set of Trial 1 data is available.

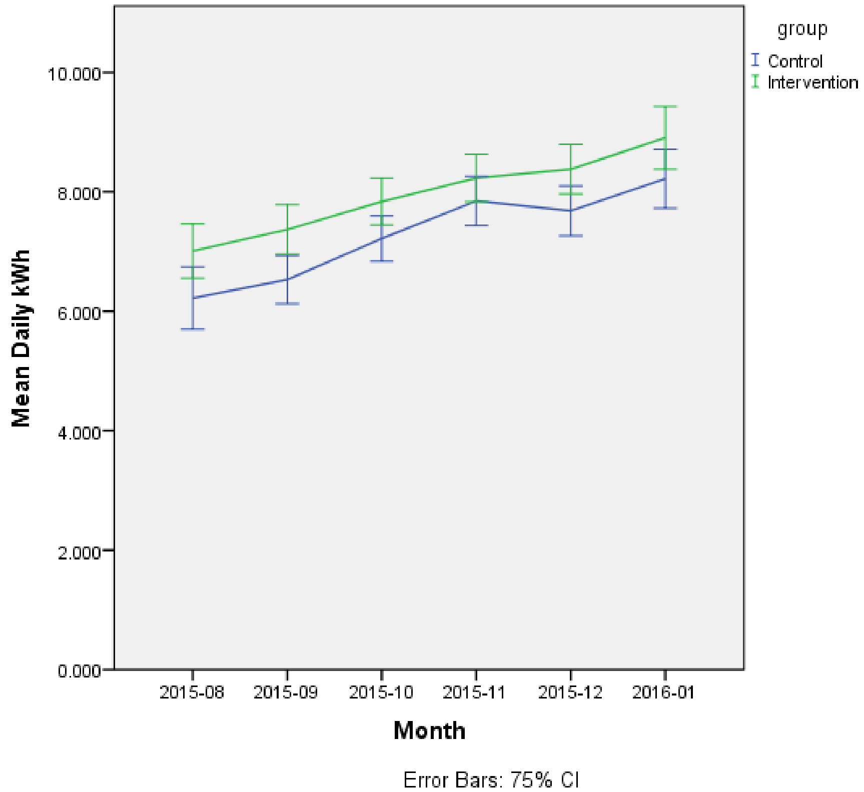


Figure 33: Mean daily kWh by month and group (CI = confidence interval)

5.4 Trial 1 control-group contamination effects

There are a range of factors that can impact on the integrity of the control group as a baseline against which to define savings in the intervention group. The primary factors that need to be considered in this context are:

- Experimenter bias;
- Differential attrition;
- Selection bias;
- Diffusion; and
- Rivalry/demoralisation.

In the context of the **energy**wise project, the primary concern is differential attrition between the intervention and control group. This can contaminate the control group by defeating the randomisation process by which they are assumed to be statistically equal at the start of the project. Assuming the integrity of the randomisation process (and there have been no reports of any breaches of this from project partners) then the intervention and control groups should start out being statistically insignificantly different. This of course, does not mean, that they would be identical. As the analysis of household size shows, there is one eight person household and one nine person household in the trial. By definition these must end up in either the intervention and control group with there being a 1:4 chance of them both ending up in the same group. As it happens they have both been allocated to the Intervention group in the trial. In addition, there seems to be a skewing of the distribution of household sizes towards the smaller household size in general within the control group and the larger household size within the intervention group. This falls within the range of expected random variation between the groups so could be entirely independent of any trial induced contamination effects.

An alternative explanation is that this difference may have arisen due to a greater number of dropouts from the control group than from the intervention group. This is an example of differential attrition, possibly through demoralisation. Some of the qualitative feedback returned from the CFOs and researchers participating in the focus group meetings suggest that there has been some level of dissatisfaction/misunderstanding around the participants in the control group not receiving the smart meter and energy savings devices at the start of Trial 1. Theoretically this may have given rise to a greater propensity for participants within the control group to withdraw from the trial thus making the intervention and control groups unequal. However the impact of this effect on the **energy**wise project appears to be minimal, with 48% of active participants in the control group and 52% in the intervention group as of 31 January 2016.

In order for this factor to impact upon the findings of the trial, it would be necessary for the additional dropouts from the control group to be non-random. In this case, there would need to be a greater propensity for larger households to have dropped out of the trial if they were in the control group. There is no a-priori theoretical reason to expect this to be the case. One can post-hoc rationalise that differential dissatisfaction in trial participation between the intervention and control groups would disproportionally impact on larger households if it only takes one household member to object to the participating for the household to withdraw. If each household member is independently equally likely to more strongly object to being in the control group to the intervention group, then this would increase the probability of the household dropping out as household size increased. Further analysis of the grounds for withdrawal may be able to provide some evidence supporting or refuting this hypothesis although it is unlikely to be able to establish it beyond doubt.

In conclusion, at the time of writing this report there is no meaningful evidence of any contamination effect, however further analyses (particularly using data from the external control group, see Appendix B: External Control Group) available in subsequent reports may provide further insight into this.

5.5 Statistical generalisation

The research design for **energy**wise was developed as a balanced response to the need for robust findings that can be generalised to UK Power Networks and Great Britain, tensioned against the costs to the project and the logistical constraints of working with vulnerable and fuel poor customers in a constrained geographical area.

The design of the trials was based on two main objectives:

- Firstly the capacity to say (with a known level of statistical confidence and power) the likelihood that the effects of the interventions are real (**internal validity**);
- Secondly to be able to say how likely it is that the energy savings and shifting we see in those who received the interventions apply generally, i.e. would happen if we did the same interventions elsewhere (**external validity**).

At bid, the project external validity sample size was based on being 90% (‘Z’ in the equation below) confident that the project’s estimate of the mean energy savings in the population (i.e. other DNO regions) would lie within 5% (±2.5%) (‘A’ in the equation below) of that observed in the **energy**wise intervention group. As discussed in the project’s bid submission, a sample size of 271 resulted. This is based on the standard assumptions of inductive statistics and was calculated using the standard equation for statistical generalisation produced below.

The inputs used in this inductive statistics calculation for the **energy**wise project were as follows:

$$n = \frac{\left(\dfrac{P[1-P]}{\dfrac{A^2}{Z^2} + \dfrac{P[1-P]}{N}} \right)}{R}$$

- N = The population was set at 260,000 based on information from UK Power Networks on the number of people on the Priority Services Register. While this is an underestimate, sample size does not change for population sizes above this value.
- P = 0.5. This is assuming that half the population will save more than the estimated median energy savings of 6% and 50% will save less than 6%. This figure of 6% was the estimated median energy savings calculated during the trial bid through looking at the range of energy savings observed in other trials of similar sets of interventions in the UK and Ireland.
- A = 5%

- Z = 1.6449 for 90%

The requirements for 90% statistical confidence for the external validity calculations were not the limiting factor on the sample size calculations which was dictated by those for internal validity. This required 275 in both the intervention and control groups (given the other input assumptions to the calculations available at the time) giving a total of 550 participants. At the time of undertaking the data analysis there were 337 participants in the trail. This will allow the project to estimate the mean energy savings in the population represented by the **energy**wise sample to within 5% (±2.5%) of that observed in the **energy**wise intervention group with ~93% confidence (under standard external validity assumptions). Estimations to each of the 14 DNO regions will be subject to some additional uncertainties reflecting the extent to which the **energy**wise target population differs between these regions. Analysis of the between DNO region variances in the external control group should allow the project to estimate and thus quantify these regional differences (see Appendix B: External Control Group.

5.6 Qualitative insights

The research has been designed to enable qualitative insights into participants' energy using behaviour to be captured. This is done through recording observations of the interactions that the CFOs have with participants at their homes while carrying out the HES. The HES is typically done with residents' participation helping the CFOs to document the electricity using appliances in their homes and record socio-demographic information. This interaction can generate broader conversations about energy use at home, and the CFOs have been trained to record any qualitative insights generated through these interactions. After each visit to a home for an installation, the CFO should make notes about any comments made by the participants about energy use. They also document their own observations about the use of the energy in the home, for example noting if the lights are on in the day, or the television.

The objective is to create a set of qualitative notes that provide qualitative data on:

1) Engagement with the **energy**wise project (recruitment channels, materials, experiences etc); and
2) Lifestyles and impact on energy use in the home (e.g. family routines, health, use of appliances).

The qualitative notes are structured around four themes; energy types, life and routines, energy issues, **energy**wise experience and are flexible enough to enable other observations to be recorded. Capturing these insights has been carried out where possible. In total qualitative notes for 157 participants have been collected by the project[19].

When analysing the qualitative notes, it appears that there are two areas that are of particular interest for the project research; firstly appliance use and comfort practices and secondly daily routines and appliance use. The notes also provide some useful insights for the project implementation including comments on the project materials and the experience of filling in the surveys.

<u>Heating practices and thermal comfort</u>

Comments on heating are common in the notes database (present in 97 out of 154 records) and raise two issues; firstly the choices people make about how to keep warm which may or not involve using central heating or electric appliances; secondly strategies which people use to keep warm when their central heating is faulty.

Alternative heating practices

Three participants commented that they avoid using their central heating because they do not like the feel of it. For example for one it brought out her son's allergies another explained that in winter he '*tends to dress warm and use halogen heaters if necessary as central heating gives him a migraine*', while another explained *"they*

[19] This figure includes 29 sets of notes from participants who left the project after their HES / installation visit was carried out and the notes created.

don't use heater or heating during winter a lot as the wife has a skin condition which is worsened with heat. Tend to wear more clothes to keep warm".

Others explained they tried to reduce their use of central heating to reduce their outgoings. For example "*customer often uses electric fire and not central heating as it 'costs too much'*", *"Uses heat blanket to keep warm during winter"* or *"even during winter the customer stated they try not use the heating".*

Two participants spoke about preferring the instant heat from additional heating and using central heating at other times. For example, a CFO has noted that one household '*want to get warm instantly when they get home from work they use additional heating instead of the central heating that takes longer to heat up. Central heating is on later in the evening and weekends when home*'.

These comments indicate a variety of heating practices that may have an impact firstly on the project's implementation. Such alternative practices will be hard to detect with the temperature loggers and may mean the project team makes inappropriate interventions. For example a person might be wrongly flagged as living in a cold home, when the customer is warm enough due to their chosen alternative heating practices. Of more concern though are the cases where the central heating is faulty and the landlord needs to take action, rather than the tenant. In these cases intervention may not solve the issue.

Faulty central heating
Faulty central heating was mentioned in six cases and four of these participants explained that they had to use additional electric fires to compensate. One provided their perspective, explaining that "*the heaters don't work properly*" and that "*they think new radiators might make a difference to heating but also to bills*" however as a social tenant, their housing provider is responsible for maintaining radiators. The participant therefore has limited options to improve the heating system in their home.

These comments raise concern about the ability for fuel poor customers to realise the benefits of a time-of-use tariff as the household's ability to respond to the benefits of cheaper electricity offered in a time-of-use tariff will be limited. In the worst cases where electric appliances are being used to compensate for faulty gas central heating or poorly performing buildings, the participant may incur higher bills for continuing to use electric appliances to heat, or may under heat in order to save money.

Routines and appliance use
The qualitative notes raise a number of insights about how family life and domestic routines affect appliance use. Research carried out for the LCNF CLNR project has raised the issue of how domestic routines affect DSR measures. This is because some household routines which are shaped by broader societal rhythms such as school times and working hours are less able to be shifted temporally to lower peak demand (Powells et al. 2014).

For the participants in the **energy**wise trial there are three insights from routines and appliance use that may affect a household's ability to respond to time-of-use tariffs and shift their electricity consumption patterns.

Appliances move around with extended family members
The qualitative notes indicate that as extended family members move between households they alter not only the pattern of electricity consumption, but also the appliances in the home. For example one respondent explained that "*every weekend the grandchildren visit and bring their PS3 and Xbox with them*". Childcare and appliance use appear to be connected with tablets, laptops, TVs and consoles all mentioned as appliances used by younger children, whether these are resident in the home, or visitors. The pattern of childcare and its associated electricity use may prove hard to shift unless people associate childcare with electricity consumption and see this as an area of consumption that can be altered in line with tariffs.

Another factor mentioned by some participants is that extended family members help out in the home, for example one person stated that their "*daughter visits twice a week to help out with the cleaning, washing & bills etc.*". This again shows that the timing of appliance-use is tied to dynamics that extend out of the immediate household and bill payer's control.

This raises interesting questions about the extent that extended family members can support or undermine a household's ability to respond to time-of-use tariffs. The ESC survey provides us with insight into the type and extent of resources that participants have within their social networks to understand electricity and energy efficiency in the home as well as how this form of social capital is operationalised. Further research could look specifically at the question of using these ESC resources to realise benefits of Time-of-use tariffs.

Participant comments on the **energy**wise project

In addition the qualitative notes contain some insights that are useful for learning lessons about the design and implementation of the project. The notes contain 52 comments on surveys and these show that almost all found them easy to fill in. Only one person found the HES time-consuming, while two found the focus on appliances and brands a little confusing. Three people raised concern about the confidentiality or sensitivity of the data, specifically mentioning the income questions. More positively, two people specifically mentioned that having a Bengali-speaking CFO was a help.

Overall, the low level of concerns or comments about the surveys suggests that they were well designed and well administered making them easy to fill in for the majority.

5.6.1 Qualitative feedback from participant interviews

In April 2016, qualitative telephone interviews were held with 30 **energy**wise participants, selected at random, to gather feedback on the recruitment and installation and also, for Group 1, on their energy display and devices. Those in Group 1 were generally very positive and there are some reports of energy savings.

- *"It's a very good project, it's very useful. You can manage your budgets much better. I used to put £25 a week on my meter, now I put in £20 every other week. It's a big saving. The meter helps me to know where I'm at."*
- *"Everything has run smoothly. I think the new meters are good. I've heard the scare stories, but I wouldn't want to change it."*
- *"I'm on a pay as you go meter – it's great to see on the energy display how much energy I'm using, and when I need to top up."*

16 Group 1 interviewees were interviewed as part of this research. However, one of these interviewees chose not to answer the questions about their use of the equipment supplied as part of the trial. All of those who did answer these questions had received the equipment, although one participant suggested that they had only received one LED light bulb.

Kettle

Eight of the 15 interviewees said they were using their energy saving kettle. Some of those who were using it were extremely positive about it, with two people commenting on the energy saved and one on the speed with which it boils water. For example, one interviewee, when asked what they thought of the kettle, responded:

- *"It's brilliant. You can just fill up what you need, rather than too much"*

Others who were using the kettle were less positive about it, with negative comments being made about the quality of the materials used, its appearance and its weight. A number of interviewees had taken time to adjust to the kettle, with some not fully understanding how to use it at first. For example, one interviewee had been frustrated about the amount of water which could be boiled in the kettle and had only just learnt that the water in both chambers could be boiled at the same time. One interviewee suggested that a sticker on the kettle handle with simple usage instructions would have been helpful.

Seven of the 15 interviewees were not using their energy saving kettle. Reasons cited included:

- The kettle had stopped working (2 interviewees);
- The kettle was difficult to use, e.g. an elderly participant found the button to release the water too difficult to push, whilst another simply found this process annoying;
- The kettle had insufficient capacity;
- The kettle was not needed (this participant said that they rarely boiled water); and
- The kettle was too heavy.

LED light bulbs

11 of the 15 interviewees said they were using their LED light bulbs. They were being used in a variety of different rooms.

All those who were using their bulbs were happy with their performance. Some commented on their performance in terms of the light they provided, whilst others commented on the energy saving aspect. Two minor concerns were expressed. One interviewee suggested that the LED bulbs were a little slow to react (this may have been a reference to other energy saving bulbs not supplied as part of the trial), whilst another found that they were a little too bright.

The four interviewees who were not using their LED light bulbs gave various reasons for this:

- One had just not got around to fitting them;
- One couldn't fit them because of being physically unable to reach the light fittings;
- One stated that the bulbs did not fit the light fittings they had; and
- One intended to use them but was waiting until their existing bulbs had failed.

Standby shutdown

Seven of the 15 interviewees said they were using their standby shutdown. Those who were doing so were generally positive about it, with comments being made about its ease of use and its contribution to saving energy. As an example of the latter:

- *"The kids moaned a bit that they have to wait a bit in the morning for everything to come on, but I told them that we were wasting lots of money having it on all night, and they've got used to it now."*

Three of those who weren't using the standby shutdown said that the reason for this was not knowing how to operate it. Two others suggested that they didn't need it, as they turned everything off at night anyway. One was fearful of unplugging her TV and other devices in case they stopped working, whilst another intended to use it but hadn't got around to installing it yet.

Smart energy display

13 of the 15 interviewees said they were using their smart energy display. Most of these were doing so regularly for monitoring energy use and, where relevant, credit. For example:

- *"It's in the front room. I use it to check my credit and how much I'm using each day."*
- *"It's by the side of my telly. It shows me what I'm using and how much credit I have left."*
- *"It's next to my microwave. It switches itself on at 6am. I check it in the morning and the evening."*

When asked if their behaviour had changed as a result of using their smart energy displays, seven stated that it had. In some cases this was significant. For example:

- *"It does help. You try and cut down on things. Instead of doing my washing every day, I do it every 2 days. And I use my tumble drier a bit less. I use a drying horse more"*
- *"Yes, big time. Seeing how much I was spending amazed me. Seeing how much the microwave and oven use, has made me much more aware. Me and my son (who's 5) turn off all of the lights now. We never did that before"*

- *"The other day I was cooking a Sunday roast, the kettle was on, the washing machine was on - the display went up to the max, I realised how much it was using. I made the kids turn off the telly and go upstairs. They love reading. I'm more conscious of switching things off. I turn all plugs off at night. I have always been good with lights"*

In other cases, the interviewees felt that the changes they had made were more minor, with a number suggesting that they had always been very careful with their energy use anyway.

Two of the 15 interviewees said they were not using their smart energy display. One had experienced technical problems with the display and was unsure how to operate it. The other suggested that they had not found the device useful or clear and also expressed concern about the energy use of the device itself:

- *"It seems to defeat the object. It uses energy, although the team told me it doesn't use much"*

Seven of the 15 intervention group interviewees reported experiencing some problems in using their smart energy displays. They mainly described them as delays in credit showing up on the meter when topping up through the display. Customers are always shown at the installation appointment how to manually input the vend codes into their meter to top up in case of any potential delays in the communication between the smart meter and the display. In one instance, a participant did not remember how to do this and activated their emergency credit between making the top up payment and manually inputting the vend codes, which they claim was stressful. These customers now know how to top up manually, if necessary, so this situation should not reoccur.

Energy saving advice leaflet

Six of the 15 interviewees said they had read the energy saving advice leaflet. Six said they had not read it, whilst two could not remember. One interviewee was not asked this question due to a lack of time.

Three of those who read the leaflet said they had found it useful but only one reported having implemented any of the advice in the leaflet. This interviewee suggested that they had implemented the advice about use of the energy saving kettle and about turning off devices not in use. This seems to correlate with the findings shown in Figure 17 to Figure 20 in Section 3.6, where picking up or reading a leaflet is not people's first response when looking for information on energy.

6. Network insights

6.1 Half hourly 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 (known as the EELG) that is specific to their network structure and is capable of forecasting load growth resolved to the level of individual distribution substations. The 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 & industrial sectors;
- 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 technologies[20]. 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 34.

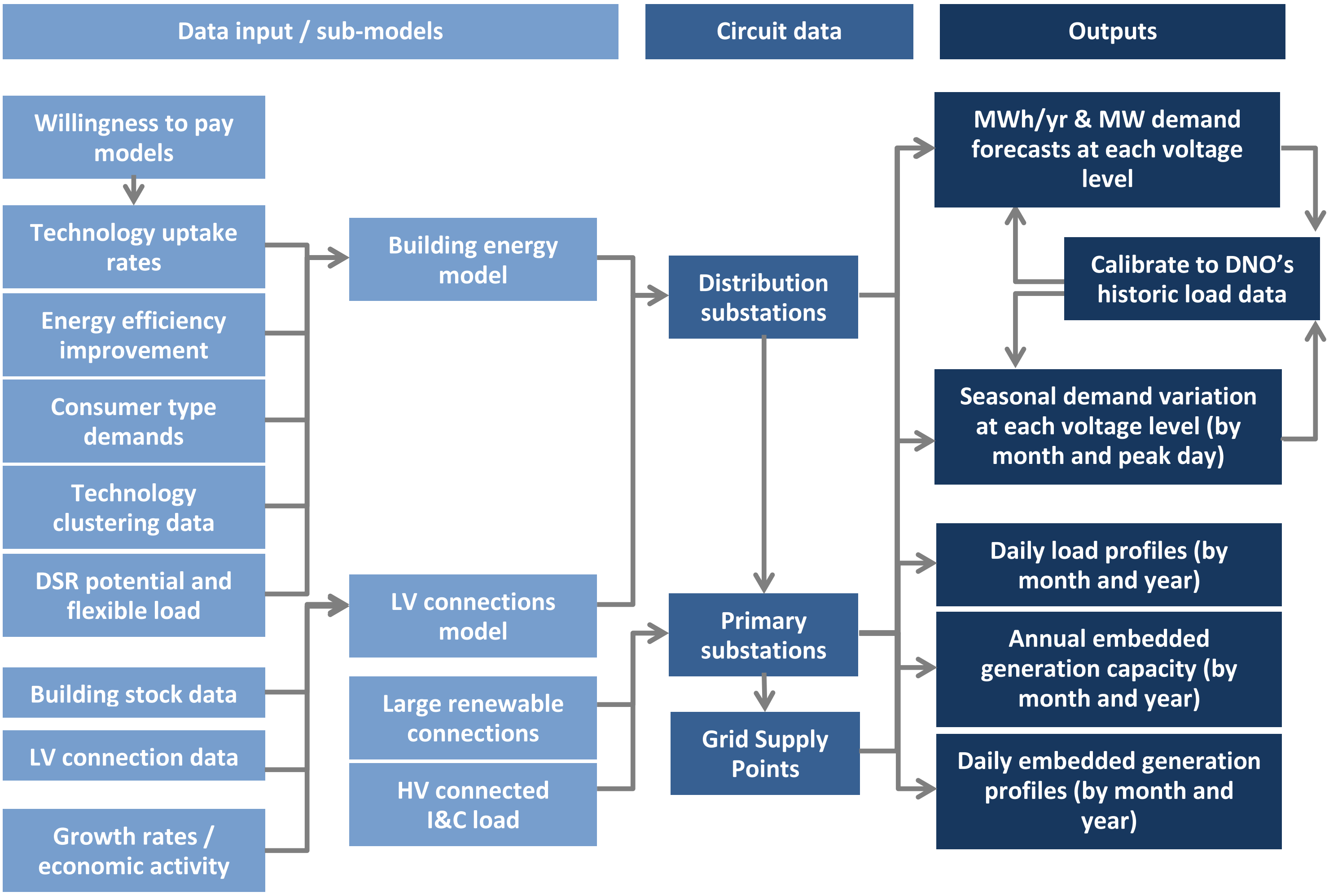


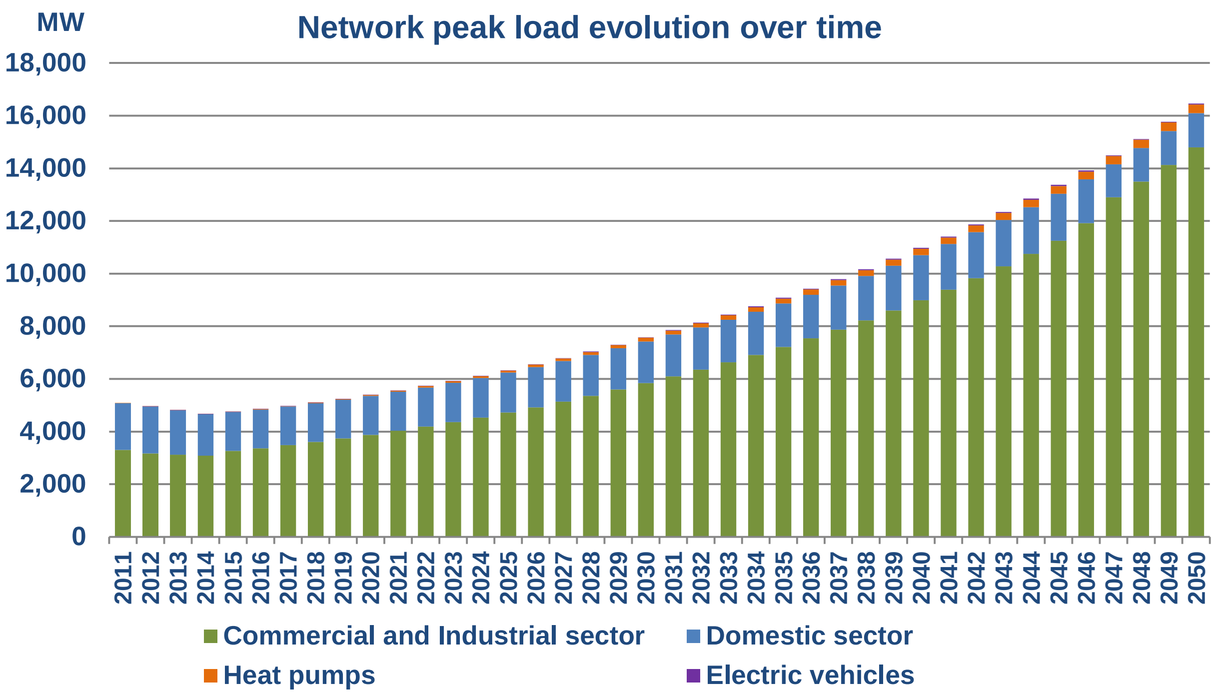
Figure 34: Simplified schematic of the Element Energy Load Growth Model

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 35 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.

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



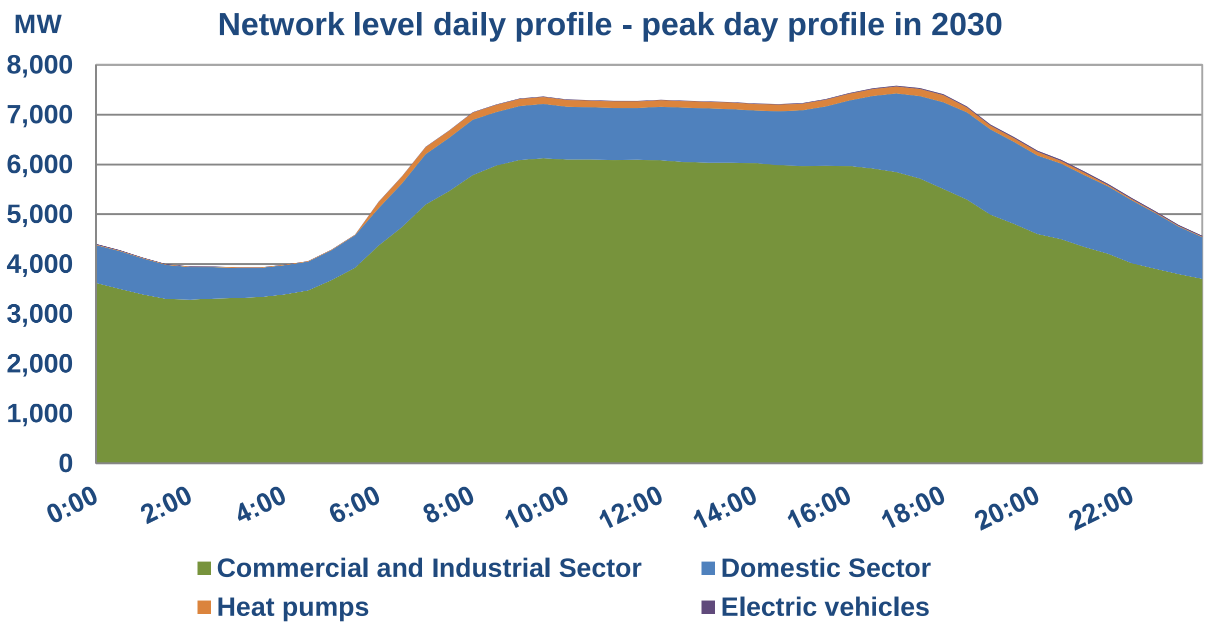


Figure 35: Example outputs from the EELG model. The top chart shows the evolution of peak load over time at network level. The bottom chart displays a typical load profile forecast for a specific future year at network level

6.1.2 Updates to the Element Energy Load Growth 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 2014/2015, 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 **energy**wise 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 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 **energy**wise 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, at the completion of the **energy**wise trial, it will be 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.

6.2 Half-hourly household load profile trial data

6.2.1 The energywise half-hourly household load data

This section provides an overview of the half-hourly trial participant load data from the **energy**wise project, which is then compared to that of other UK smart meter trials. Similarly, the load profiles of the **energy**wise trial participants are also compared to the network load profiles at the primary and secondary substations connected with the **energy**wise trial.

For this report, only a limited sample size of half-hourly household monitoring data is available since data is still being collected for various customers. As such, this report is designed to provide a snapshot of early findings based on six months of trial data for credit meter customers. It should also be noted that while smart meter data extraction and transfer is still being optimised, the number of customers for which half-hourly data is available is less than the number of customers for which daily consumption data is available.

Figure 36 illustrates the number of households for which half-hourly household monitoring data was available at the time of preparing this report (as of 31 January 2016).

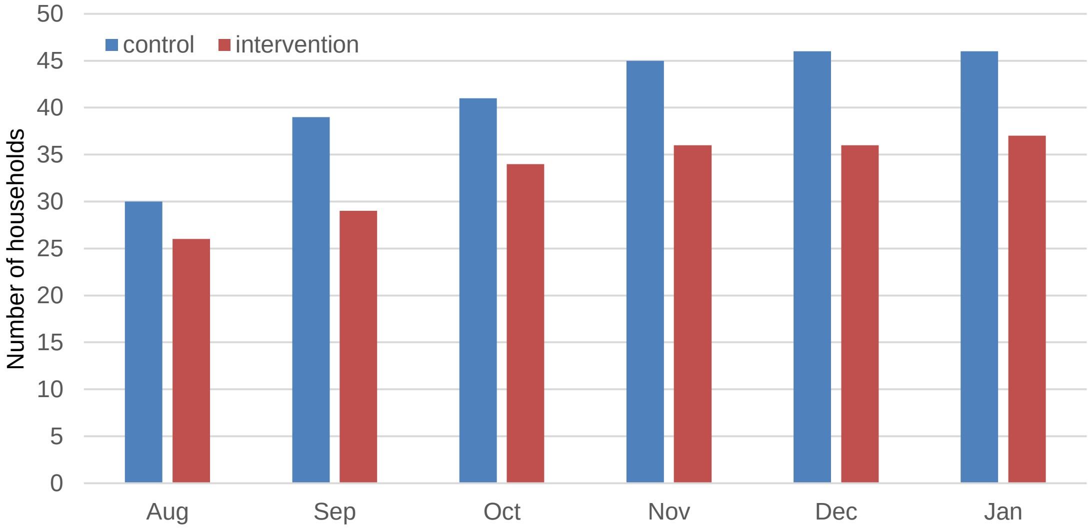


Figure 36: Number of trial participants for which half-hourly data is available

As discussed in Chapter 5, at this intermediate stage in the trial where not all data is yet available for all the recruited participants, there is currently insufficient data available to identify a statistically significant energy saving in the intervention groups. It is anticipated that once data from all participants is available for analysis at the end of Trial 1 that the issue of statistical significance will be able to be addressed. As such, this chapter will focus on the load profile of the control group in the **energy**wise trial to identify early learnings in relation to the electricity usage characteristics of fuel poor customers (as represented by the participants in this trial) and how the participant load profiles relate to those of the network assets to which they are connected. This preliminary analysis will be updated at the completion of the trial with the full trial dataset, at which time the analysis of realised savings from the energy efficiency interventions in this trial will also be presented.

The following sections address the half-hourly monitoring data of all available credit meter customers in the control group. Figure 37 displays the monthly average diurnal load profiles, derived from the half-hourly data of the control group.

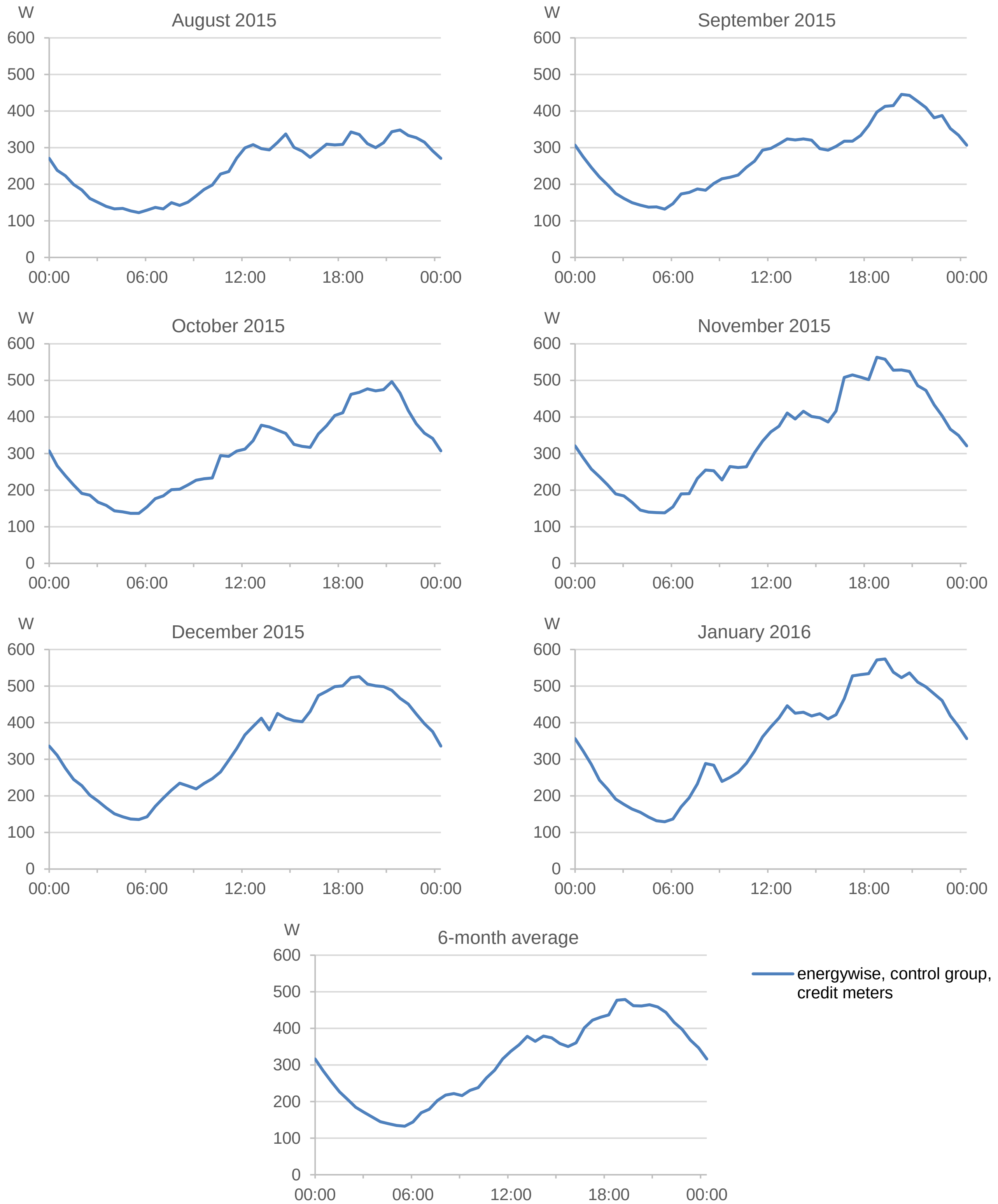


Figure 37: Diurnal load profiles of energywise trial participants across calendar months: 6-month snapshot from half-hourly data available to date (control group, credit meters)

6.2.2 Comparing the energywise household load data with that from LCL and CLNR

In this section the half-hourly load data from the **energy**wise control group is compared with the results observed from the LCL and CLNR smart meter trials. Both the LCL (Figure 38) and CLNR (Figure 39) projects conducted smart meter trials with large control groups, which serve as a reference for comparison with the **energy**wise trial data.

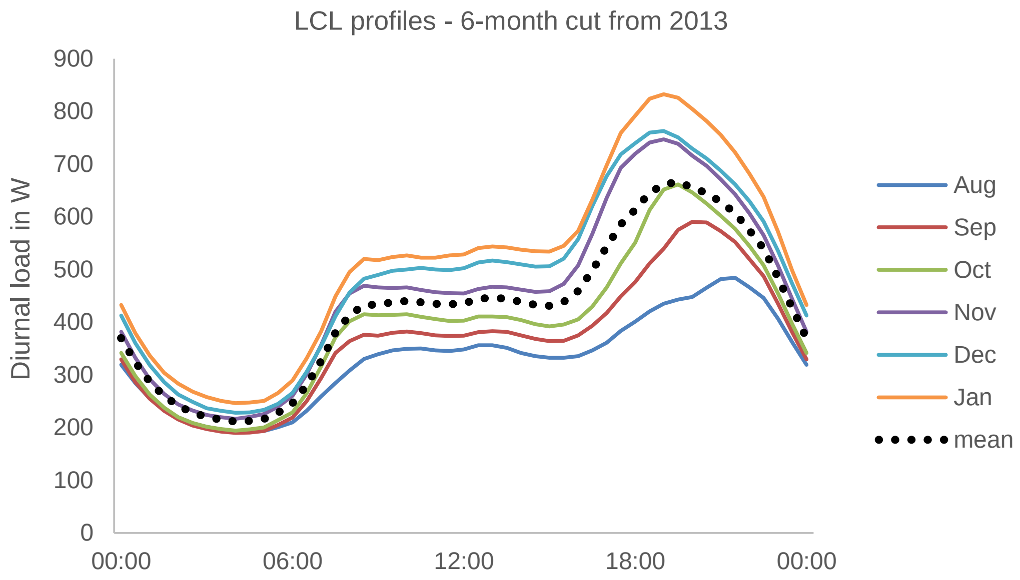


Figure 38: Diurnal load of LCL control group participants. The data represents the load of households in the regular smart meter trial (no interventions) monitored in London during 2013

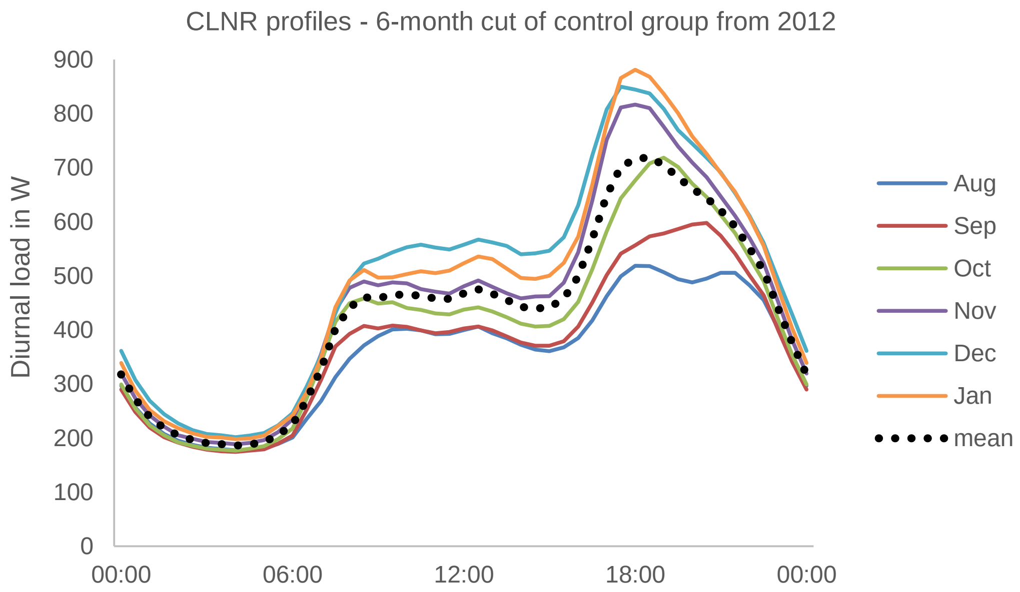


Figure 39: Diurnal load of the CLNR control group – referred to as "test cell 1a" (TC1a). The data shown here represents the average load of households monitored in the UK for the year 2012

The average household diurnal load profiles for **energy**wise (Figure 37), LCL (Figure 38) and CLNR (Figure 39) in the six months from August to January reveal the common trends that would be expected for typical household consumptions profiles across these months:

- The consumption and peak load is higher during the winter months;
- The evening peak occurs relatively early during the winter season and moves to a later time in summer; and
- The characteristic shape of the diurnal profiles in each trial remains similar over these different seasons with an increase in "peakiness" (i.e. an emphasising of the evening peak) during the winter period.

Figure 40 below compares the average six-month household load profiles (August – January) across the **energy**wise, LCL and CLNR control groups. It can be seen that the average consumption of the **energy**wise trial participants is considerably lower than that observed for the LCL and CLNR trials over the same months. This is in keeping with the findings of the LCL trial analysis[21] of the impacts of household income on average diurnal consumption profile and reflects the demographic composition of the participants in the **energy**wise study, which is targeted at fuel poor customers.

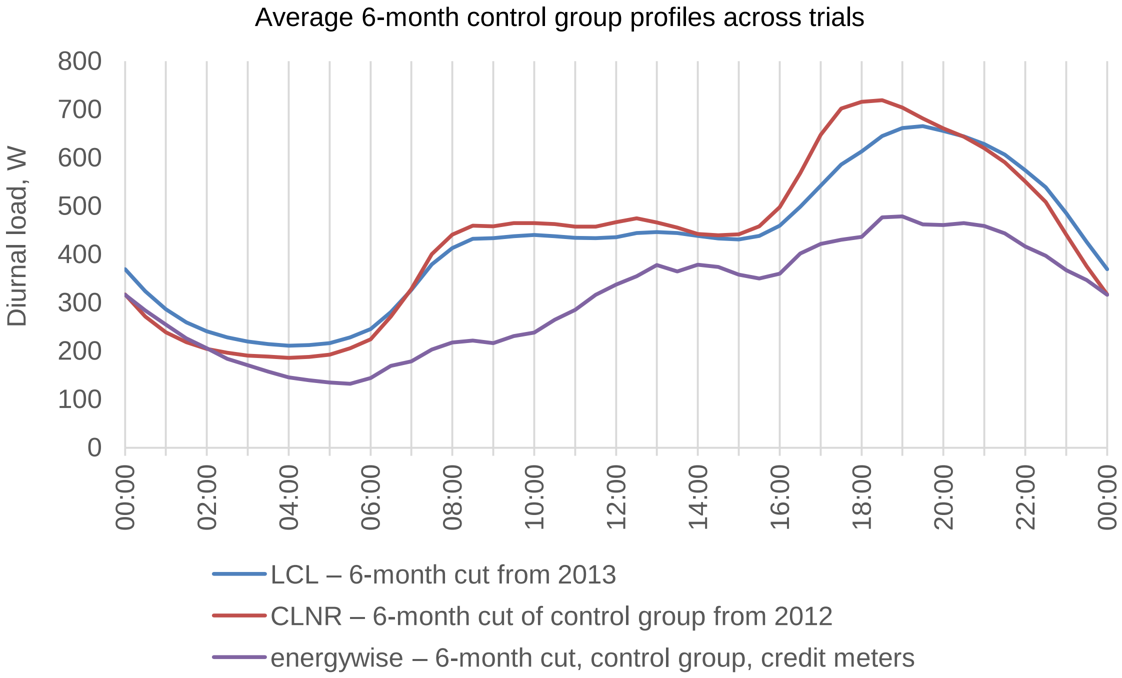


Figure 40: Average six-monthly profiles across the control groups of energywise, LCL and CLNR

At this intermediate stage in the **energy**wise trial, there are also early signs that the load profiles of the **energy**wise participants may display a relatively lower morning demand (between about 8am and midday) than observed in the other trials. However, this profile attribute is not typically observed in the intervention group of the **energy**wise trial, so this may be an artefact of the small sample size of half-hourly load data available for this report and will be further investigated in the updated report when all trial data is available.

The evening peak of the **energy**wise and LCL trials occurs slightly later than that observed for the CLNR trial over the same months. This may be indicative of geospatial and lifestyle differences of the London-based participants of the **energy**wise and LCL trials relative to the broader geographic distribution of CLNR trial participants (about 50% of which were from the Northern Powergrid network region and 50% were recruited more broadly within the UK).

[21] Element Energy, "LCL Learning Report C3 – Network impacts of energy efficiency at scale", for UK Power Networks, 2014

As a proportion of overall demand, the **energy**wise trial participants also exhibited relatively high early morning (between about midnight and 3am) demand levels. In absolute terms, the early morning demand levels were comparable to those of the higher average energy consumers in the LCL and CLNR trials. This trend was also observed for the intervention group in the **energy**wise trial and will be examined in more detail at the completion of this trial when additional load profile data is available.

6.3 Half-hourly network load profile data

An important objective of the **energy**wise project is to understand how network loads are impacted by fuel poor customers and their engagement with energy efficiency and demand shifting interventions. To provide some early insights in this area, the following sections of this report provide a comparison of the average load profiles of **energy**wise trial participants 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 LPN's licence area, there are 234 primary substations, which connect to 17,791 secondary substations[22], which in turn connect (via feeders) to various end-users (e.g. households and businesses) served by the network. Of the many primary and secondary substations within LPN, this project deals only with those connected, via the network hierarchy, to the participants on this trial.

6.3.1 An introduction to the half hourly network data

The project has identified all the secondary and primary substations the **energy**wise participants are connected to using the MPAN associated with each household. Out of these, 75 secondary substations associated with those trial participants active as of 31 January 2016 have been monitored by the project in trial 1. Substation data is transferred through a Remote Terminal Unit (RTU) installed at primary and secondary substation level. Note some sites do not have an RTU installed (therefore no data is available from them) or the RTU was not configured properly. Those RTUs that need correction have been raised internally by UK Power Networks with the aim of getting these RTUs fixed for the updated report. However, data cannot be extracted retrospectively and these secondary substations will only be monitored from the date of resolution of the RTU configuration. All available 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 has been extracted from all monitored secondary (kW) and primary substations (MW) from May 2015 to January 2016 and both datasets have been transferred to Element Energy to perform the network modelling.

6.3.2 Secondary substations

6.3.2.1 Aggregated secondary substation data

Figure 41 shows the average diurnal load of these secondary substations for the six calendar months relevant to this report. 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 across each of the six calendar months. This is likely to be due to the high proportion of domestic customers (approximately 90% of customer connections) that are connected to the secondary substations associated with the **energy**wise trial (i.e. these are secondary substations operating in predominately residential areas). As would be expected from a substation load profile that is largely made up of domestic loads, the evening peak is observed to occur later in the summer months and earlier in the evening during winter months as is typically observed for residential load profiles.

[22] Based on 2014/15 RIGs data

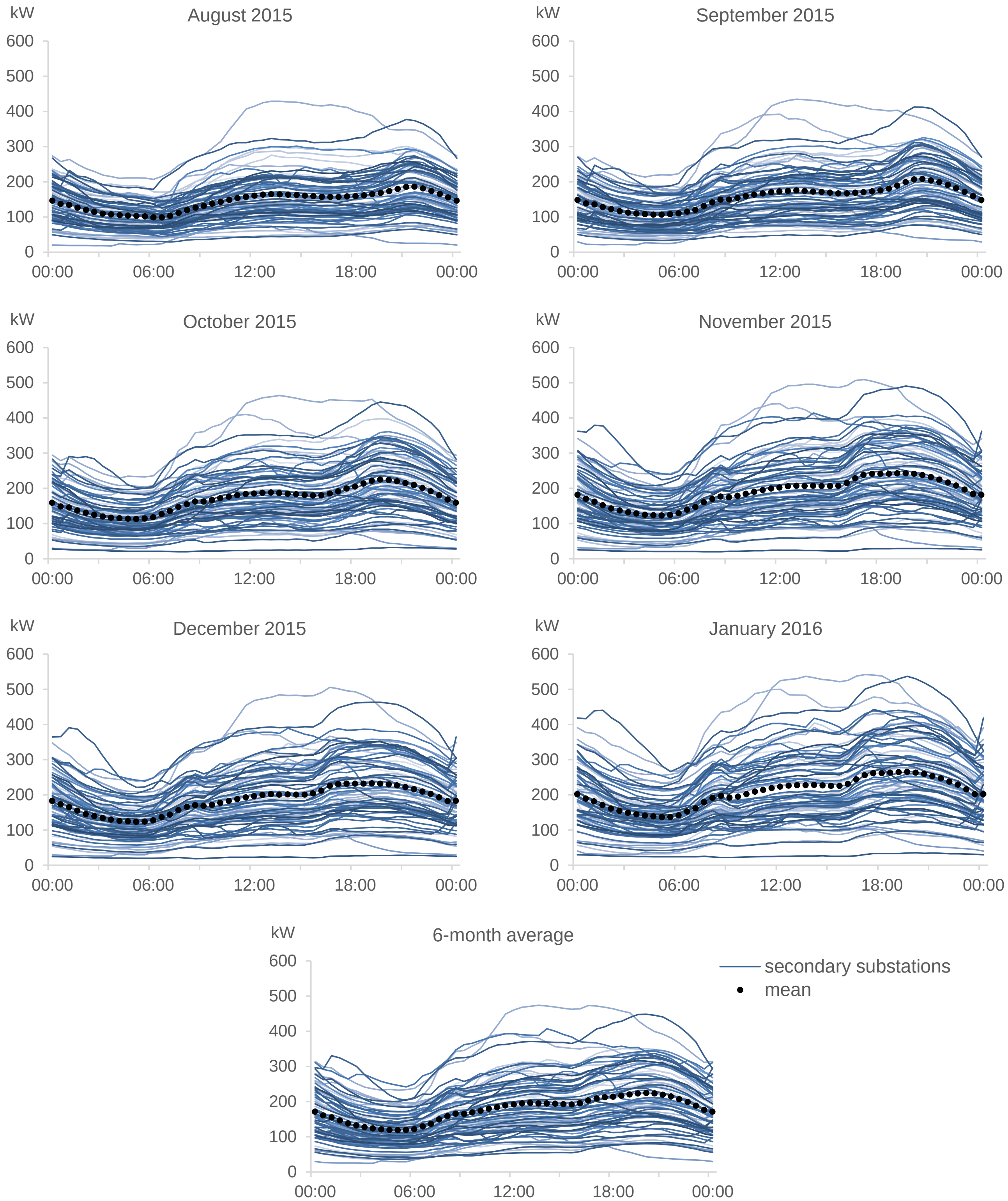


Figure 41: Average diurnal load profiles of the secondary substations associated with the energywise trial.

6.3.2.2 Correlation of trial impacts with network loads

As can be seen in Figure 42 the peak demand for the **energy**wise control group aligns well with that of the mean secondary substation load. By comparing the seasonal variation in the **energy**wise participant profiles (Figure 37) and secondary substation profiles Figure 41), it can also be seen that the shift in the timing of the evening peak aligns well between the two over all months monitored so far in the trial.

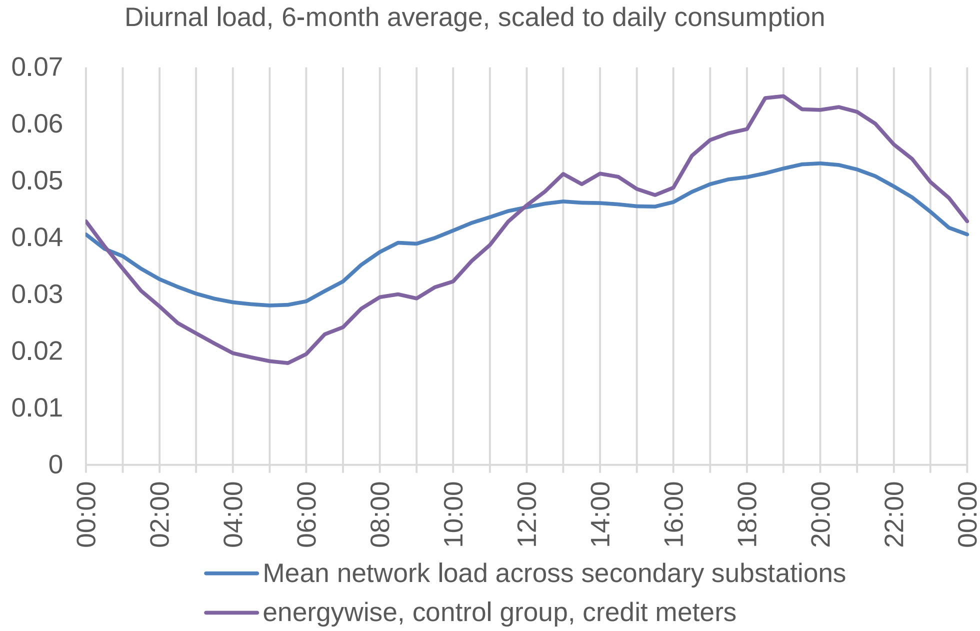


Figure 42: Comparison of the mean network load of energywise secondary substations with the load profile of the energywise trial participants. In each case, the 6-month average (August 2015 – January 2016) is shown

The strong correlation between the **energy**wise participant profiles with the mean secondary substation load profiles indicates that energy saving and peak shifting responses from the trial participants have the potential to directly benefit the secondary substations to which they are connected. As more trial data becomes available, the extent to which the **energy**wise trial participants engage with energy efficiency and peak load shifting interventions will be examined, as will the extent to which the reduced or shifted household loads correlate with the loading of the secondary substations.

6.3.3 Primary substations

6.3.3.1 Aggregated primary substation data

The project is monitoring seven primary substations that are associated with the **energy**wise trial. Figure 43 displays the average load profiles of these seven substations for the six calendar months relevant to this report.

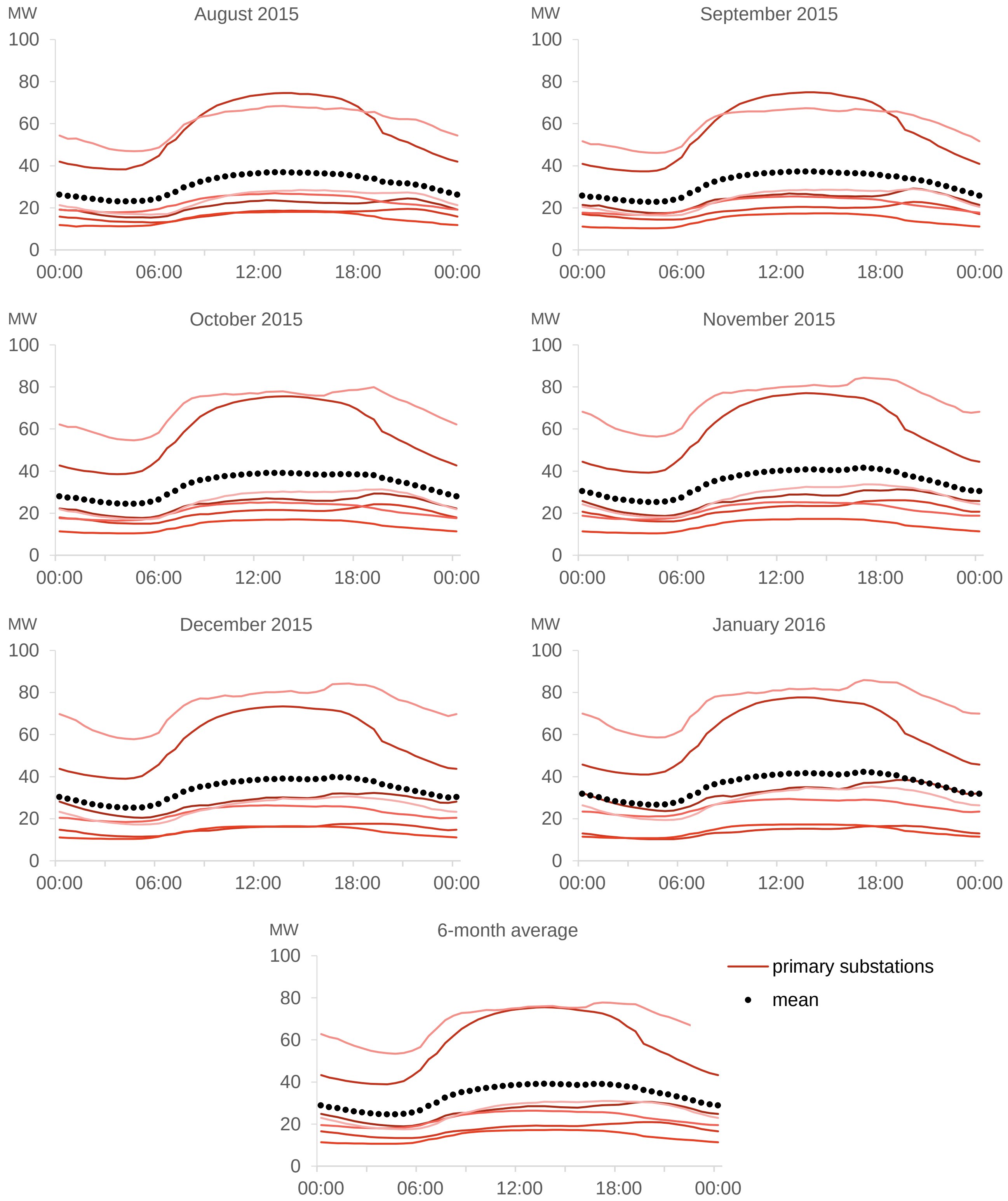


Figure 43: Average diurnal load profiles of primary substations associated with the energywise trial

As can be seen in Figure 43, the mean profile shape for the seven primary substations exhibits a much flatter (without a particularly distinctive evening peak) and more seasonally consistent load profile than observed for the secondary substations. This reflects the larger proportion of commercial and industrial loads represented at these primary substations.

6.3.3.2 Correlation of trial impacts with network loads

As can be seen in Figure 44, the correlation of the **energy**wise trial participant load profile shape with that of the mean primary substation load is less than that observed for the secondary substations discussed above. This reflects the more diversified nature of the primary substation loads and the higher proportion of industrial and commercial loads (which typically increase loading during the daytime) at this level.

Primary substations will still benefit from wide-scale fuel poor customer engagement with energy efficiency and load shifting interventions, though in the case of the primary substations connected with this trial, the impacts may not align to the substation peak loads as closely as in the case of the secondary substations. It is worth noting that many of the primary substations shown in Figure 43 have a high proportion of industrial and commercial load. In the context of broader fuel poor interventions across Great Britain, it may be that the primary substations involved have a higher (or possibly lower) proportion of domestic load and hence greater (or lesser) alignment with the energy savings and demand shifting observed for fuel poor customers.

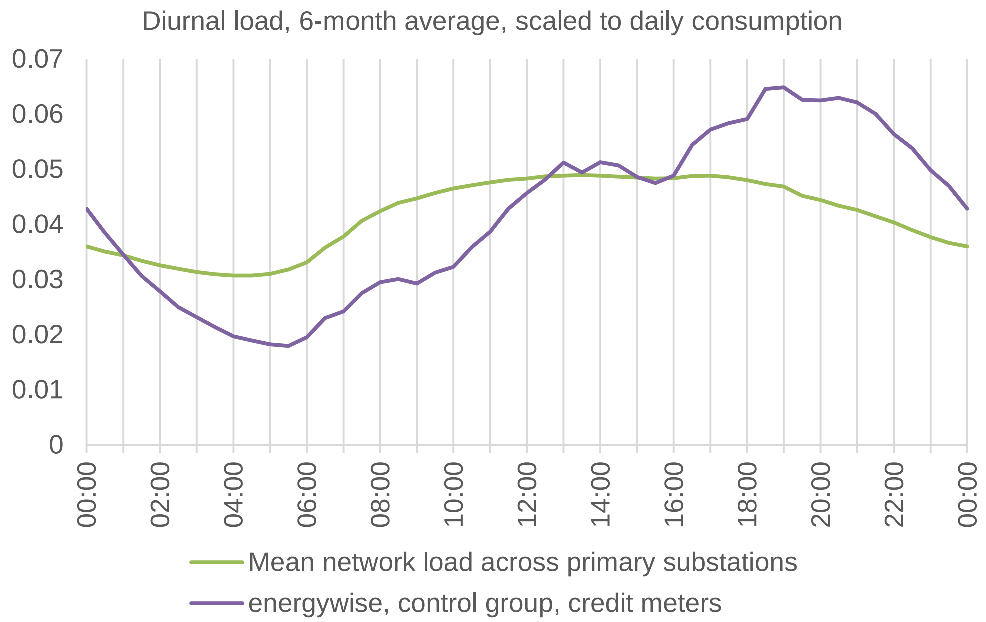


Figure 44: Comparison of the mean network load of energywise primary substations with the load profile of the energywise trial participants. In each case, the 6-month average (August 2015 – January 2016) is shown.

7. Comparison against technical potential

7.1 Technical potential trial impacts

To obtain a sense of the scale of energy savings that could be realised in Trial 1 of the **energy**wise project, the technical savings potentials for each of the Trial 1 intervention devices was estimated. These interventions included:

- Three LED lightbulbs;
- An Eco-Kettle;
- A standby-saver device; and
- The provision of a smart meter and smart energy display (i.e. a real-time display).

It is worth noting that an energy efficiency booklet and support advice were also provided as part of the interventions in Trial 1 of **energy**wise. However, the impact of these additional measures are not considered in this technical potential analysis[23]. The technical potential energy savings for each device were determined using appliance level load profile data from DECC and Defra's Household Electricity Usage Study (HEUS), average household appliance ownership and household consumption data for the "Adversity" smart meter group from LCL, 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 45 and are based on the following assumptions:

- Three existing lightbulbs (based on the average lightbulb ownership mix for "adversity" type households in the LCL trial) 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 would be 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 meters[24]. 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 **energy**wise project and applied the savings to the average annual load profile of the "Adversity" smart meter group from LCL.

[23] 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.

[24] 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.

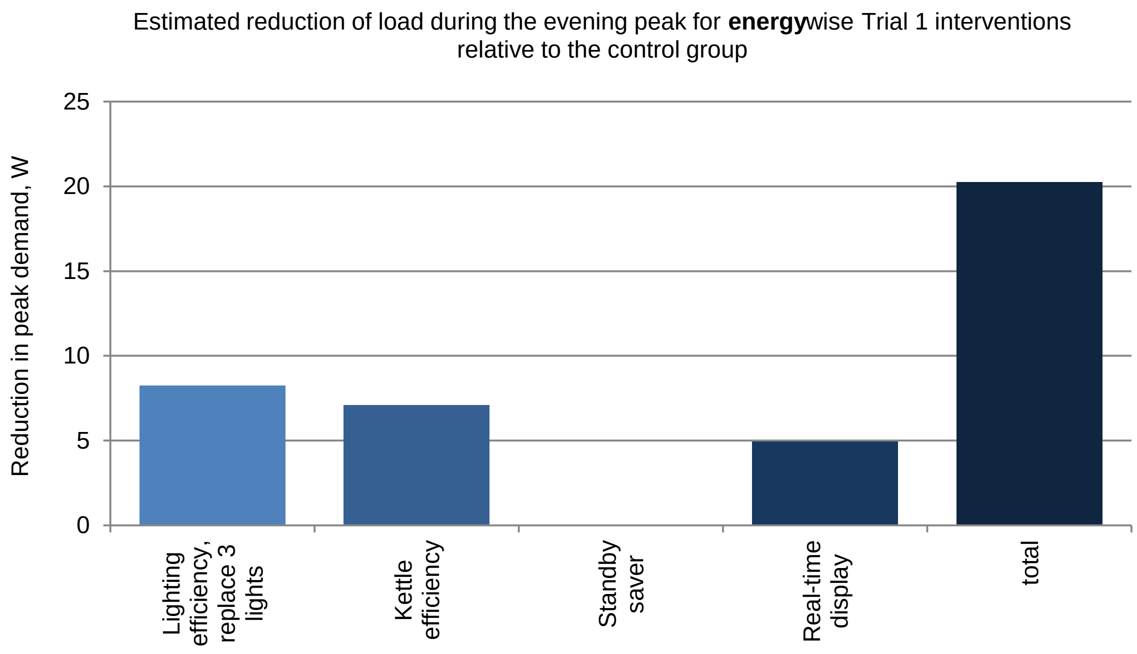


Figure 45: Estimated technical potentials for reductions in peak demand that are possible for the interventions in Trial 1 of the energywise project relative to the control group

As can be seen in Figure 45, the total technical savings potential for the **energy**wise Trial 1 interventions is approximately 20 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). It is recognised that the savings realised in **energy**wise Trial 1 will likely be less than this technical potential as not all appliances may be used by each household or they may be used in a non-optimal manner (e.g. the high efficiency LED lightbulbs might not be installed, or they might be installed in a rarely used room; the Eco-Kettle may not be used or its savings features may be overridden or the real-time display may not be utilised).

7.2 Comparison with measured savings observed in the trial

It is too early to draw robust conclusions about the effect of the intervention on energy savings between the intervention and control groups. As shown in Sections 5.2 and 5.3 the sample sizes are currently too small to date (due to the non-inclusion of the prepayment customers) to support such analysis. Therefore, it is not yet possible to compare the realised energy efficiency savings in Trial 1 to the theoretical potential savings identified above. Rather, this analysis will be conducted at the completion of Trial 1, when the full trial dataset is available. At this time, the realised savings of the intervention group relative to the control group will be compared with the technical savings potentials identified above and the realised savings will also be scaled up to identify the potential impacts across the UK Power Networks licence areas if these interventions were rolled out more widely.

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 have been consented, they will be surveyed about their personal circumstances to provide the project with greater confidence about their suitability to take part in the project. 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, will 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 is being 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 8.1.6;
- Work affecting participants' power supplies; where smart meters are installed, energy supply is 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 focused 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.) As of May 2016, this log had issues recorded by 12 customers, including for example:

- Instances where CFOs organised to replace participants' equipment that wasn't working or which the customer reported having not received;
- Disengaging a customer from the project because they moved to a different property;
- Chasing up an outstanding installation appointment on behalf of a customer;
- Logging the fact that one participant will be temporarily decanted from their property while work is carried out;
- Instances that had been referred to the Disclosure Board for consideration (see Section 8.1.3 below) since they concerned either participant or customer safety; and
- Instances that had been logged on the Vulnerability Spreadsheet for discussion via that forum (see Section 8.1.2 below).

8.1.2 Vulnerability

In identifying customers eligible to be invited to take part in **energy**wise, 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 dependent on electrically operated medical equipment) were not invited to take part;
- Those who are blind/visually impaired (since no IHD suitable for the visually impaired was available);

- Those in debt to British Gas; and
- Those who were highlighted as “seriously ill”, or “confined to bed” were also excluded by British Gas.

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 should it is deemed suitable, the customer would have gone through a disengagement journey out from the project.

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),
- **Red** – high 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, has identified eight households considered at high risk (**red**) and seven at medium risk (**amber**) out of those still participating in the trial.

The outcome of the preliminary review has been shared with any relevant partners (the social housing providers, UK Power Networks, British Gas, University College London, Bromley by Bow Centre and CAG Consultants) in double-anonymised form (i.e. without using the project’s unique ID but simply adopting a numbering convention, e.g. customer 1, 2, 3) and a group review has been performed for those households identified under the Amber and Red categories who are still participating in the trial. As a result of this group reviewed:

- Two Amber households identified as having medically equipment in their home were upgraded to Red (making total of ten high risk households);
- Eight of the high risk households have medically operated equipment. Whilst it was stated that such households would not be included in the trial, project partners are in agreement that 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 others 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;
- The other seven households were agreed to be low risk and will remain in the trial. These included two households where there is someone who is blind or partially sighted within the home; these will be kept in the trial as the person signing up to the trial was seen by the CFOs as being able to read the information provided and therefore should not have any problem with using the energy display; and

- Two of the 15 red households are on prepayment meters. Given their highly vulnerable status, British Gas, in line with their BAU activity, will contact these customers and offer to switch them to credit meters. If they do choose to switch, they will remain in the project but their data will not form part of the Trial 1 data analysis (since they would be ineligible due to having changed meter types). However, it will be possible to include their data in the Trial 2 analysis (assuming they choose to sign up to the ToU Tariff).

Additional procedures that are in place to ensure safeguard for those that are most vulnerable include a password scheme operated by British Gas for its PSR customers.

Also before the commencement of recruitment activities the customer CFO team have been Disclosure and Barring Service (DBS) checked and two members of the current team have received training from National Energy Action in identifying vulnerability. This covered: defining and identifying vulnerability; the potential impacts of vulnerability; identifying fuel poor households; and sources of help and support for fuel poor households.

Of the 538 customers that signed up to the project, 12 made requested special arrangements, the majority of which (nine) involves requesting interaction with a CFO who spoke Bengali. This is in line with the HES findings showing that first ethnic group in the sample population (out of those who returned the survey) is Bangladeshi, with Bengali being the most common first language together with English (see Section 3.4), and it demonstrates the importance of having a local team with language skills close to the ones of trial participants. One requested assistance from a CFO in completing the ESC survey, another requested visits only from a female recruiter and another requested that only a specific recruiter visit.

These arrangements have been recorded to ensure a high level of customer service. Provision was made to provide customers with communication materials in alternative formats to suit their needs; no request for this has been made to date.

In addition, two key mechanisms have been developed to protect vulnerable customers – the disclosure board and the temperature monitoring protocol, both of which are outlined below. A participant panel has also been set up to provide general 'health check' on the project and enable regular, structured feedback from a group of participants which may include customer protection issues.

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 customer field officer team.

Within the installation phase, three disclosure boards had been held aiming to address matters that arose from the installation appointment booking process or during the installation visits.

The first two boards had been requested and chaired by UK Power Networks under exceptional circumstances as they identified specific circumstances that required the attention and prompt decision of the disclosure board. UK Power Networks has handed back chairing activity to Bromley by Bow Centre for escalation protocols and in the administration of the board as per the agreed disclosure board terms of reference and a refresher on the disclosure procedures has been also provided to the CFO team.

Seven cases were addressed at the disclosure boards held in 2015, including for instance:

- A customer that turned to the project to get support to resolve a technical issue with a faulty gas boiler;
- A vulnerable customer with carer;
- A broken item found by a customer post installation visit; and

- An elderly customer has had their gas supply capped due to faulty cooker identified during project installation.

In each case the suitable resolution process was discussed and agreed with the project partners taking part to the disclosure board. For example, the case of the elderly customer with faulty cooker was treated with highest priority as the customer was identified as vulnerable. Local partners identified support programmes the customer could have been referred to and with the support of an East End Energy Fit project advisor the customer was awarded £200 crisis and support grant to replace the faulty cooker.

Dependent on the seriousness of the case, the participant may be removed from the trial so that they can receive appropriate advice and support. To date no participant has been identified 'too vulnerable' to take part to the project as part of the Disclosure Board process. Those leaving the project will receive a leaving pack including the Consumer Services Charter (Figure 46) providing advice and signposting to local and nationally available services relating to reducing energy costs. Where possible, it is also envisaged that they are referred to other services as appropriate.

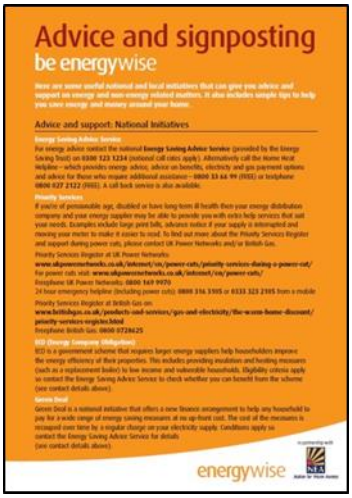


Figure 46: Consumer services charter

Learnings

As a result of the learnings from the operational phase of the project, the terms of reference of the Disclosure Board have been 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 al issues raised, and only those issues relating to safety should be escalated to the Disclosure Board, at the decision of the customer field officer manager.

Therefore the following changes have been finalised by the CFO manager in May 2016: three separate protocols have been developed depending on the type of issue the CFOs are 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.

8.1.4 Customer panel insights

Two participant panels have been established, one for each group, which will meet regularly over the course of the project. The purpose of these panels is to provide a structure for participant feedback and a sounding board for participant views.

Membership is open to all **energy**wise participants, with information on applying to join the panels contained in the welcome pack. In addition, the project team actively targeted at recruitment at selected participants to ensure that the membership generally reflects the geographical spread and demographic makeup of the research participants as a whole. Participants are offered £30 in vouchers for each panel attended, as a thank you for their time. (It should be noted that there may have been a recruitment bias in the panel members in that we focused on recruiting people whose ‘customer journey’ hadn’t been too problematic.) Each panel is attended to have around 6-8 participants; for the inaugural panel meeting in March 2016, there were six participants at each panel.

Panel meetings are facilitated by staff from CAG Consultants with a researcher from University College London observing and taking notes. The **energy**wise CFO team organises and attends the meetings.

Key findings – inaugural panel meetings, March 2016

The inaugural panel focused on gathering participant feedback on the recruitment and installation process.

Recruitment
There was consensus amongst participants that the **energy**wise letter was necessary to make people aware of the project and the fact that they’d been selected to participate. Some felt that a letter which emphasised the British Gas connection, making it very clear that the letter wasn’t about switching energy provider, would have increased confidence/interest. The explanation of the project by the CFO was key to understanding the project and joining, and all participants were very positive about the CFO team.

One participant felt strongly that door knocking visits should not be made after 5pm and said that door knocking from two men could be intimidating to some. Several felt comfortable discussing the project with women. Some were attracted by the feeling of being ‘selected’; the fact that the project was not open to all. Participants liked the fact that appointments could be fitted in around personal schedules.

The main motivations to take part were the potential to save money and the offer of vouchers.

There were suggestions that the recruitment materials could been a little simpler, whilst some of those in Group 2 felt strongly that it was important for them to be aware from the outset that there were two groups and this should have been made clearer at the point of recruitment and in the information.

Installation
Most felt the installers were good and were happy with their contact with them. (Please note the comment above regarding potential recruitment bias.) There was a general consensus that the installation team was very good and made the process easy, although two participants had had problematic installs and most had had post-install visits to rectify issues such as temperature sensors falling off the wall. In general, this did not seem to have generated much ill-will. It was felt it would be good for there to be more flexibility in how the kit could be installed in the home to work with individual preferences and situations.

There were some low level concerns about the technology and how much to interact with it.

Participants weren’t asked for their views on the IHD or energy saving kit; this will be covered in subsequent panel meetings.

General communication
Participants were positive about the communication they get from the project and about the CFO team.

The books of stamps sent with the surveys are very popular and seen as being a good and novel way to encourage participants to return their survey.

Customer protection issues

Nothing was raised at either panel meeting regarding any customer protection issues.

Participants were positive about the panel and all were keen to be involved in future meetings.

"*I was nervous about coming to the panel, as I'm not someone who likes speaking out, but I enjoyed the process and I'm more confident about it now.*"

8.1.5 Insights from participant interviews

As part of the evaluation of the **energy**wise participant recruitment, phone interviews were held with a randomly selected sample of 30 participants. This exercise was proven effective in terms of customer protection to pick up uncovered problems that participants hadn't proactively reported to the **energy**wise team. For instance, some of the prepayment customers reported they experienced some delays when topping up through the Smart Energy Display with credit not showing up immediately on their meters (see Section 5.6.1). A British Gas investigation proves there has been little contact from these customers regarding this matter, suggesting the importance of having in place different customer engagement channels particularly for projects targeting this segment of population.

8.1.6 Temperature monitoring

A key component of the project's approach to customer protection is the monitoring of temperature in participants homes. Whilst the homes on the trial are all gas heated, there was qualitative evidence presented earlier in the report which shows that additional electric heaters are in use in several homes, and people's usage of them could change as result of the trial. There was a wider concern that people may be confused with the messaging and seek to make savings by turning their gas heating down. For this reason, the project instituted a process of monitoring temperature in the home as an early warning sign.

8.1.6.1 Temperature monitoring protocol

Through a series of workshops, project partners have jointly developed a protocol for monitoring the temperature of customers' homes and for taking action where necessary. Temperature is being monitored for:

- 'Trial effects' – to test whether participating in the trial is reducing internal temperatures in participants' homes to potentially dangerously low levels (and hence potentially resulting in negative health effects) as a result of the trials; and
- 'Condition effects – to determine if participants are experiencing dangerously low temperatures in their homes as a result of their living conditions (independently of any effects of the trial).

Two remote temperature loggers have been installed in the homes of all trial participants at the same time as the smart meters/data loggers; one in the living room and one in the bedroom (see Figure 47). These record temperatures at regular intervals.

University College London receives a monthly data file from Passiv/British Gas providing temperature data for both rooms. In addition, Passiv produces a daily report on homes where the temperature has dropped below a

Figure 47 - The temperature monitoring equipment

certain point for three consecutive days, as per the thresholds listed below. These thresholds were agreed with partners, based on 1987 guidance from WHO on the health impacts of low indoor temperatures[25] .

The action depends on the effect observed, as explained below:

Trial effect
In the event of a significant difference in temperature being observed between the two groups, the action will be to send all participants (in both groups) an energy advice leaflet which provides information about how to economically heat their home and information on where to go for further help or advice.

Condition effect
In deciding the appropriate action to take in terms of the trigger point being reached in individual households, consideration will be given to the following issues:

- The level of risk to the householder (e.g. were they at home when the trigger point was reached, are they vulnerable to suffering ill health due to low or high temperatures);
- What the appropriate action would be (i.e. what help can be offered). This may include a home visit by one of the field officers, and/or referrals to advice agencies; and
- Whether this action would necessitate the participant being removed from the trial.

8.1.6.2 Resolution of temperature logger issue

The project has experienced a number of customers whose temperature monitoring data has not been returned to PassivSystems. This is due to a mix of technical and behavioural reasons. The temperature monitoring equipment must remain powered on and connected to the internet in order to return data (please see Section 9.7 for lessons learnt). 381 customers were installed with temperature logger equipment, of these a total of 275 had missing data alarms activated.

On 16 February a corrective action plan commenced to resolve some of the missing data. Bromley-by-Bow centre issued a project letter provided by British Gas to the 238 affected households, asking customers to reconnect their devices and giving clear visual instructions on how it should look. This was then followed by a door knocking activity by Bromley-by-Bow Centre where 237 properties were visited; of which 103 customer were available (43%) and 134 were not available (57%). This activity was followed by outbound calls to the customers: 119 customers were called; 54 customers answered these calls (45%) and 65 did not (55%). The objective for both activities was to correct customers' equipment on site or raise an engineer home visit where required.

3% of the alerts (eight households) were resolved by the customers following the receipt of the letter; considering those interactions where the customer has been reached. 30% of the door knockings (31 households) and 4% of the outbound calls (two households) resulted in the resolution of the alerts. A total of 107 engineer visits were arranged, of which 99 were successful in reaching the customer which resulted in 86 visits successful in restoring sustained communications (87% of the visits attended by the customers) as illustrated in Table 8.

Due to the volume of outstanding number of customers not returning data, and repeated loss of data communication following a successful visit, a second wave of the corrective action plan commenced on 16 May 2016. To use resources more effectively and conduct a more targeted door-knocking, the strategy was modified having the customer field officers doing outbound calls first, followed by a door knocking and PassivSystems' visits booked from 23 May onwards.

The second wave of the corrective plan is in progress. A preliminary view of the outcome of the different interactions with the customers as of 10 June 2016 is provided in Table 8.

[25] WHO (1987) *Health impact of low indoor temperatures: Report on a WHO meeting*, World Health Organization, Copenhagen.

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Table 8: Overview of the outcome of the temperature missing data corrective plan

Wave	Method	# households approached	Response rate (%)	Success rate (%)
			[how many successful in reaching the customer]	[out of those successful in reaching the customers, how many were successful in resolving the alert]
1st	Letter	238	100%	3%
	Door-knock	237	43%	30%
	Outbound call	119	45%	4%
	Passiv visit	107	93%	87%
2nd	Letter	174	99%	6%
	Outbound call	165	82%	9%
	Door-knock	73	29%	0%
	Passiv visit	110	98%	77%

8.1.6.3 Early observations and next steps

Condition effect – exception reports

PassivSystems produce a daily report on homes where the temperature has dropped below or risen above a certain point for three consecutive days, as per the thresholds listed below (Table 9). A project decision was made to amend the temperature exception report "TEMPDROP1"from 18 degrees Celsius to 16 degrees Celsius. This ensures the project is immediately aware of significant threshold changes for all customers on a daily basis.

Table 9: Temperature exception report criteria

Criteria	Description
Tempdrop 1	Sustained temperature drop below 16 degrees. List all homes where over the last three full days (i.e. midnight to midnight) maximum recorded temperature in both Zone A and Zone B is less than 16 degrees
Tempdrop 2	Large temperature drop to 12 degrees. List all homes where over the last three full days (i.e. midnight to midnight) minimum recorded temperature in both Zone A and Zone B is less than 12 degrees

For winter 2015/16 (up to an including April 2016), exception reports were received for 24 households. 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 they are 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 1kWh 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. This found that:

- Seven households were considered to be high risk;
- Nine households were considered to be medium risk; and
- Eight households were considered to be low risk.

The following action was agreed in terms of these 24 households:

- No action for those at low risk;
- Those at medium risk to be monitored closely during Trial 2; and
- Those at high risk to receive a courtesy call from the CFOs and a subsequent intervention as appropriate.

Project partners are still in the process of discussing appropriate action to take during Trial 2 and will reach a decision on this no later than August 2016.

Trial effect – aggregated temperature analysis (Intervention vs Control group)

The primary purpose of comparing the mean daily temperature of the intervention group compared to the control group is to determine if there is any trial effect on household temperatures. A trial effect in this scenario would be if the impact of being in the trial influenced the intervention group to experience lower indoor temperatures compared to the control group. An indicator of a trial effect would be average temperatures of the intervention group being lower than the control group or temperatures dropping more rapidly in the intervention group than the control group.

Figure 48 shows that the intervention group experiences slightly higher mean temperatures (0.16˚C averaged over all months) than the control group and the difference in temperature between the groups remains relatively constant through the period available for this report. Additionally both groups appear to experience the seasonal impact of lower external temperature in a similar manner. Therefore there is no evidence of a trial effect from this analysis. Please note that the difference in temperature between the groups is not statistically significant.

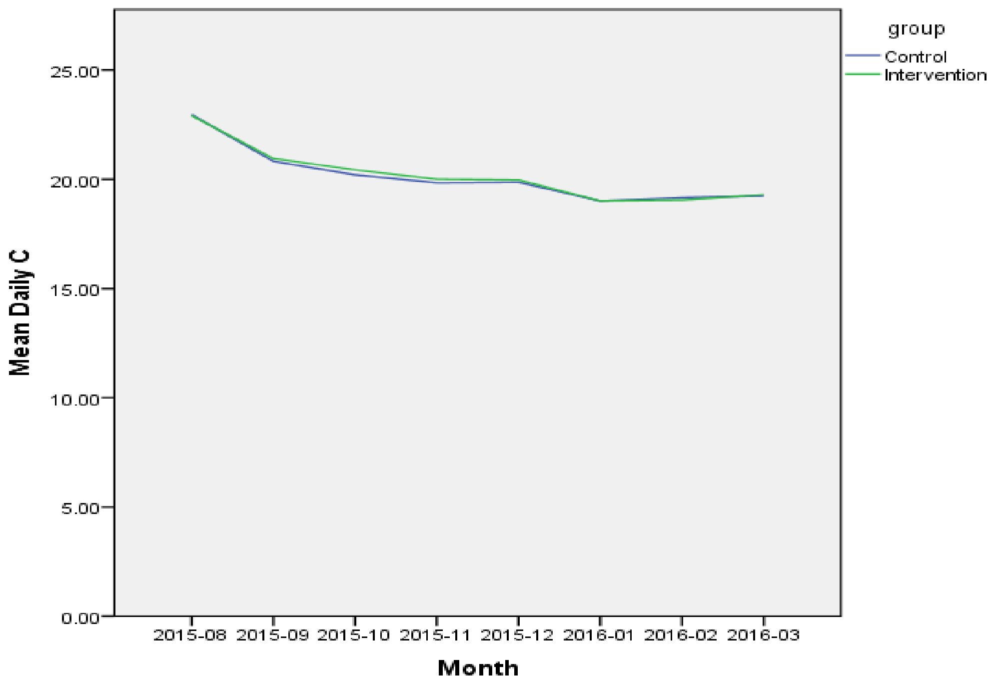

Figure 48: Comparison between the monthly mean temperatures observed in intervention group and those recorded in control group

8.2 Compliance to Comms Plan and Data Privacy Strategy

The **energy**wise Communications Plan and Data Privacy Strategy committed project partners to a suite of actions related to customer protection. To monitor compliance with these documents, actions have been listed in a spreadsheet and partners required to confirm implementation, providing evidence where appropriate. Ongoing implementation will be monitored through monthly updates to this spreadsheet.

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 10), along with the alternative action taken and the rationale for this.

Table 10: 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).
The team will keep a record of phone 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 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 will be sent end of June 2016, once all the installations have been completed and the first participant panel meetings held, designed to respond to queries raised at the panel meetings.
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 Powe 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 phone. 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.	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: • 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.
DPS Strategy 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.	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.

9. Learning Outcomes

The project to date has generated a wide range of learning outcomes. This section provides a summary of the key lessons learnt gathered through the set-up phase of Trial 1 (both selection and recruitment of trial participants), the provision of energy saving interventions through the installation phase for Trial 1, the surveys administered to the trial participants, the six month data analysis of the electricity consumption and network impacts undertaken so far, and finally though the customer protection activities undertaken to date.

The learning outcomes reported below are in addition to the lessons reported in SDRC 9.2.

9.1 Learning Outcomes: Selection of Participants

<table>
<tr><th>No.</th><th>Lesson Learnt</th></tr>
<tr><td>L1.1</td><td><u>Selection Criteria – Main Trial:</u>
In addition to the inclusion criteria for eligible households reported in SDRC 9.1 and 9.2 reports:
• A series of additional criteria were identified by project partners for exclusion of households from the project, for example leaseholders, those with energy efficiency improvements since October 2013 or planned over the course of the project and those in homes scheduled for demolition (11 criteria in total- see Section 3.1 of this report for the full list). The purpose of these criteria was to ensure:
a) that the data would not be affected e.g. by energy efficiency improvements;
b) householders were selected where there was smart metering solution available;
c) the householder would remain eligible to take part in the trial; and
d) where possible, customers who may be adversely affected by participating in the trial (such as those reliant on electrically operated medical equipment) were not invited to take part;
• An additional series of 11 exclusion criteria were applied by British Gas, including households with a theft history, those that had requested not to receive marketing materials and those with a change of tenancy in progress.
The result of this was that the pool of eligible households from which to recruit was smaller than expected – 1,352 rather than the target of 1,650.</td></tr>
<tr><td>L1.2</td><td><u>Selection Criteria – MDU:</u>
To ensure robust project learnings around innovative MDU solutions for tall and difficult buildings, the criteria for households in Padstow House were relaxed to include leaseholders, since only ten eligible customers were identified in this property, six of whom were leaseholders.</td></tr>
<tr><td>L1.3</td><td><u>External control group – timing of construction</u>
British Gas hold historic half-hourly data for all smart-meter customers and (once consent is given) this historic data can be used for external control group purposes. Thus the external control group can be constructed after the initial recruitment period, as the external control group data can be collected for the desired time period.</td></tr>
<tr><td>L1.4</td><td><u>External Control Group – Required Sample Size:</u>
For the external control group (see Appendix B: External Control Group, a sample size of 680 in each region has been chosen for the external control group, providing a 3.1% margin of error at the 90% level of confidence (exceeding the 5% margin of error requirement specified in the bid document). This larger sample size is necessary because of the need to allow for contamination effects; this sample size enables DNOs replicating the approach to be able to estimate their expected energy savings to within 100 kWh with 75% statistical power.</td></tr>
</table>

9.2 Learning Outcomes: Customer Recruitment

No.	Lesson Learnt
L2.1	**Method of Sign-up:** The vast majority (79%) of participants signed up after receiving a door knocking visit with 81% of these signing up within three door knocks. This demonstrates the importance of having CFOs interacting face to face with potential participants. Many said the invitation letter was an important precursor to this (though not enough, on its own, to persuade most to sign up; only 17 signed up after receipt of the letter). Other sign-ups came from phone calls; out of the 175 participants signing up through this route 94 (90%) signed up after three of fewer calls. Only a handful of participants requested a booked home-visit, with only three sign-ups through this route, and no-one attended the drop-in event
L2.2	**Interactions Before Sign-up:** Two thirds of participants had two interactions with CFOs before signing up and 90% of participants signing up after three of fewer interactions. 3% of participants required more than four interactions before they agreed to sign-up.
L2.3	**Reasons for Sign up:** For most participants, the main reason for taking part in the project was the chance to reduce their energy costs. For some, the main reason was better visibility of their energy use or the offer of free devices. Secondary reasons included the devices and taking part in an interesting project. Some customers also signed up to the project in order to receive a smart meter installation from British Gas. Participants' comments about the CFO team were generally very favourable, commenting on their friendly and professional approach and the role the field officers played in persuading participants to take part in the project.
L2.4	**Reasons for not Signing-up:** 43% of those invited to take part were not interested in taking part in the project. The primary reason given was lack of interest in the project (with primary sub-reasons being too much hassle, being sceptical of change or too busy), followed by ineligibility (13%), for example because they were changing supplier or moving house. 5% stated they were not interested in having smart meter, and 4% said that they did not want to take part because their bills were already low.
L2.5	**Scope for Improving the Recruitment Approach:** Some had initially thought the letter was about switching energy provider and had discarded it on that basis. Suggestions for improving the efficiency and cost effectiveness of the recruitment included: • Additional messaging with pictures and information what will be installed and by whom; • For door knocking, pair a CFO from Bromley by Bow Centre with someone from either British Gas or the housing provider to maximise take-up – and ideally also have a male/female pair; • Have a smaller team of recruiters with a higher level of training, including refresher training, and quality assurance of the door knocking to ensure accurate messages are communicated; and • Electronic capture of data at the doorstep.

9.3 Learning Outcomes: Customer Protection

No.	Lesson Learnt
L3.1	**Temperature Monitoring Protocol:** It has proved challenging to develop a protocol for taking action related to evidence of dangerously low temperatures in individual homes. Partners were in agreement that to accurately assess the risk to a household, a household visit would be necessary, but this was deemed too intrusive. A risk assessment system has been devised that uses all the information held by project partners, which is felt to offer the best approach, though is recognised as having limitations.
L3.2	**Vulnerability:** The project had committed to monitoring participants' vulnerability and to ensuring that those deemed 'too vulnerable' were excluded from the trial; specifically, it was anticipated that this would include: • Customers who are blind or visually impaired (since there is currently no IHD suitable for these customers); and • Customers dependent on electrically operated medical equipment. These criteria were re-considered as part of the vulnerability review carried out in May 2016 and it was decided that customers in the above categories should, in the majority, be retained in the trial: • For customers who are blind or visually impaired, they should be retained as long as there are others in the households and as long as the CFO has observed that at least one householder can read the project literature. • After the smart meter is installed, it was agreed that customers with electrically operated medical equipment are at no greater risk of a power outage than they would be outside of the trial and, in fact, are afforded greater protection in the trial due to the field officer team and dedicated Freephone number. It was therefore agreed that they should be retained, but that CFOs should be sensitive to their situation when asking for participants to complete surveys.
L3.3	**Customer Panel:** It proved harder than anticipated to recruit participants to become members of the customer panels. An invitation to all participants in the Welcome Pack to apply to join the panel elicited no responses, and a considerable amount of CFO time was required to recruit customers to the two panels (intervention and control groups). This was despite a £30 voucher being offered to those attending. Several participants who had said they would attend did not show up on the day, resulting in six participants at each panel (versus a target of 10-12). However, despite these challenges, the inaugural panels proved to be a very useful forum in gathering participant feedback.

9.4 Learning Outcomes: Drop-outs and Ongoing Engagement

No.	Lesson Learnt
L4.1	**Project Drop-Outs:** In contrast to the high response rate achieved the project has suffered substantial dropouts during the installation phase, with 193 confirmed drop-outs reported to the project by 14 March 2016. These can be split into: • Customers asking to withdraw from the project (110 customers); and • Customers being disengaged by the project (87 customers, four of whom also asked to withdraw). Around half of these customers dropped out after receiving the trial terms and conditions, with 1 in 7 dropping out upon confirmation of the installation appointment, 1 in 5 dropping out upon installation and 1 in 10 dropping out after installation. The single main reason for customers being disengaged by the project was that participants changed supplier. A range of problems associated with accessing homes and problems with meters contributed to the majority of other disengagements. The two main drivers for customers choosing to withdraw were the customers not wanting a smart meter and the general hassle of the installation process (linked to the disruption to participants caused by the difficulty in scheduling simultaneous installations of the smart meters and temperature loggers). A third significant factor was that customers changed their minds about the project after signing up. This may be down to success of the recruiting process in that it was able to persuade some households to participate who were only marginally interested in trial, and who took the opportunity to withdraw when other circumstances (such as issues around installation) presented the opportunity. Project partners have identified three key actions that they believe would have reduced the numbers of households dropping out: • Clearer messaging of what is involved in the project, possibly including a video; • Avoidance of the need to install temperature monitoring equipment; this can present technical issues requiring multiple visits, and which are also more intrusive as they require an installer entering a customer's bedroom (not just the hallway/kitchen, which is all that's required for the smart meter install); and • Streamline the process to reduce the number of interactions with customers.
L4.2	**Participant Interviews as Point of Escalation for Project Issues:** Participant interviews, designed to evaluate the effectiveness of the recruitment approach, have proved useful in flagging up a number of issues. The project learned that not all problems are reported to the **energy**wise CFO team. For example a few participants reported they were experiencing some problems with topping up prepay gas smart meters.
L4.3	**Ongoing Engagement:** Partners have identified a number of key learnings to maximise ongoing engagement of participants: • Keep in regular communication with participants to remind them of how useful their involvement is and to thank them for their time – with vouchers where deemed appropriate (e.g. where many customers have faced disruption due to problems with temperature monitors); • Use learning from early stages of the project to improve the process later in the project; e.g. on **energy**wise, Trial 1 learning in terms of equipment installs for the intervention group can be used to improve the experience of control group customers in Trial 2; and • Minimise customer interactions and 'hassle' to minimise dropout rates, e.g. by getting different parties to work together to attend a household at the same time where possible.

9.5 Learning Outcomes: Installation Process

No.	Lesson Learnt
L5.1	**Installation Visits:** While it was envisaged that participants would have received one single visit combining both British Gas' and PassivSystems' installations with CFO's visit (aimed at administering the home energy survey to all participants and delivering the energy efficiency devices and advice leaflet to intervention group), this proved impracticable due to the levels of resource required plus the different amounts of time required by different partners at the property. In addition, the smart meter installations required power to be disconnected which was not compatible with the temperature monitoring equipment installation that required the power to be on.
L5.2	**Installation Approach – Customer Feedback:** Most participants interviewed were happy with the installation process, though a minority were not (three out of the 30 interviewed, of whom one was very unhappy, due to problems and delays). However, several participants had had problems post installation; seven of the 15 interviewed reported experiencing problems with their energy display, particularly the gas data, which in some cases had caused problems topping up prepay meters (see L5.3), and five reported problems with temperature sensors falling off and having repeat visits to try to sort this out.
L5.3	**Prepay meters – customer training on how the vending process works** As there are several ways to top up a prepayment smart meter, the handover of knowledge from the Smart Energy Expert during the installation visit is key to the deployment of smart meters. For instance, it is important that customers are aware that they can always force this payment through to the meter manually if necessary. It is also fundamental that the information is shared among the different household members. It was observed through the participant interviews that for example in one case the person responsible for topping up the meter was not present at the install appointment and their partner, who had been present, did not share this information with them.
L5.4	**Scope for Improving Installation Process:** Partners have identified the following options for improving the installation process in any replication: • Avoid temperature logging equipment if possible as it has generated many problems. If this equipment is necessary, consider having the same organisation installing this as well as the smart meter, or at least brand the other organisation the same, and aim to minimise customer interactions; • Link up all those involves with install/delivery so that they can attend a customer's house at the same time where possible, to minimise hassle (though it is recognised that this is challenging given the different time and other requirements of the different groups); • Train up CFOs to install and demonstrate equipment where possible (e.g. the kettle and the standby shutdown), and provide a dedicated equipment manager with a van to deliver the equipment; and • Pilot the installation process with a few households and then tweak the process as necessary

9.6 Learning Outcomes: MDU Installations

No.	Lesson Learnt
L6.1	**MDU Full Shared Infrastructure:** A key learning through the project was that the MDU Communication Backbone supplied by Siemens will not offer 100% home area network coverage to the entire building/all residents as previously expected. As "channel masking" (see L.6.3 below) is not used, each flat requires an individual set of Zigbee radio equipment to ensure all Zigbee radio traffic is collected and extended through the MDU network. The equipment costs required for full building coverage depend on the number of flats within the building. Padstow House has 68 flats meaning the equipment costs are too high and would greatly exceed the project budget. Instead the MDU installation will resemble more of a point to point shared infrastructure solution. This is where equipment for only the recruited customers will be installed into the building, meaning only they will receive the extend HAN services (rather than all tenants). For example, for the two customers requiring the MDU solution, Siemens only install equipment that will collect and transmit data for their two meters within the meter room. If customers reside on building floors two and five, then the transmission equipment is only installed onto floors two and five.
L6.2	**MDU installation process:** Siemens require a list of all assets to be installed into the building pre installation in order to load these into their building control centre and enable Siemens to route the Zigbee radio traffic (containing smart meter data) accordingly to each customer.
L6.3	**MDU installation process:** The project learnt that Siemens are required to be on site for each smart meter installation due to the channel agility installation process British Gas uses when installing smart meters. Siemens are required to "sniff" or detect the Zigbee radio channel the meters are operating on and then commission their systems using the same channels for each customer. Upon commissioning the British Gas smart meter communications hub automatically searches and acquires the channel with the least "noise" to ensure the most reliable and sustainable HAN. The Siemens solution requires Zigbee channels to be fixed ("channel masking") in order to perform the commissioning remotely.
L6.4	**MDU Installation Process:** It was found that the installation process for tall and difficult building solution requires less time for engineers to be inside customer properties which greatly benefits the customers. This is because the smart metering HAN can be created outside of the customer's home (landings or hallways), meaning the meters and in home display are paired and communicating with each other before the engineer enters the property. The engineer only has to perform customer service processes inside the customer's home, not any technical work.
L6.5	**MDU Installs – Landlord Engagement**: The project has already made some valuable commercial learning regarding landlord engagement and authority to install in these tall and difficult buildings. Tower Hamlets Homes preference was to draw up a separate "license agreement" (maintenance contract) with the tall and difficult building solution supplier pre installation in addition to the original collaboration agreement signed by all project partners. More engagement and understanding amongst social landlords is required for the larger smart roll out as landlords have to be mindful about tenant benefits as well as about the commercial agreements. Due to the nature of these contracts direct communication and agreements between the landlord and the solution supplier would be best suited.

9.7 Learning Outcomes: Equipment

No.	Lesson Learnt
L7.1	**Control Group – Secondary Electricity Meter Installation:** It was originally planned that control group participants would have a secondary electricity meter installed for the purpose of data collection in Trial 1. However, it was found that for in most cases, there was insufficient space for this. Instead: • Credit customers in the control group have had a credit smart meter(s) installed but the smart energy display will not be provided until Trial 2; and • Prepayment customers in the control group have had a (space efficient) Navetas electric loop installed (this is because certain prepayment functionalities are not accessible if a prepayment smart meter is installed without the smart energy display).
L7.2	**Smart Meter Installations:** When attempting to install smart meters into flats British Gas have learnt there are additional difficulties when compared to installing into houses. Some properties have locked meter rooms which require caretaker access. Locked meter rooms resulted in several aborted installations that required rebooking, in many cases two additional visits were required as often the caretakers did not attend and allow access to the meter rooms for the second installation visit. For the meter rooms where caretaker access was not required most meters were readily accessible. However some did require a Gerder key. These are instances where the meters are locked behind a cage or metal obstruction (Gerder). This again requires either council or landlord access in order to unlock the obstruction and exchange the meters.
L7.3	**Temperature Monitoring Equipment:** Reasons for temperature data loss: During the PassivSystems corrective action plan two major reasons for data loss from the temperature monitoring equipment were observed: the temperature sensors falling off the wall and the communication hub used to transfer the data going offline.
L7.3a	**1.** Temperature sensors falling off the wall: The cause of the temperature sensors falling off the walls is believed to be either the fixing method and/or human interaction. A new fixing method was employed in July 2015, which has been shown to have good adhesion strength on most walls, with the exception of woodchip wallpaper. In addition, through supervision, the quality of installs has been improved. It is hoped that these two measures will reduce this problem.
L7.3b	**2.** PassivSystems' communication hub offline: The PassivSystems temperature monitoring equipment uses a communication hub to collect and transfer data, via the internet. This hub has to remain powered on and connected to the internet at all times in order to do so. Through the PassivSystems corrective action plan it was found that a lot of customers were unplugging either the broadband or the power source from the hub rendering it unable to transfer data. Although this is an easily resolved issue it is inherent in customer behaviour.

No.	Lesson Learnt
L7.4	**Half Hourly Data:** British Gas identified an error within the technical smart meter configurations sent to 48% of the project credit smart meter installations. This lay within a technical meter message and has not affected the customer experience, any of the customer journeys, or customer billing in any way. Upon installation the half hourly read schedule did not successfully update on some meters meaning the half hourly readings for these meter have not been returned to the read repository (where British Gas is storing the smart meter readings) and cannot be extracted. British Gas corrected the issue in February 2016. This means that the affected customers' half hourly readings are missing between May 2015 to February 2016, dependant on the smart meter installation date (Installation phase completed in November 2015). All credit customers are now set to HH meter reading schedule, the data is also being returned to the read repository. A similar error exists within the 66 smart Prepayment meter customers, 52% of the project prepayment population. Here the meters are not returning the half hourly reading schedule but have successfully received the configuration to do so. The meters are returning daily readings. This is still being investigated by British Gas and the head end service provider to determine the root cause, again this error lays within a technical meter message and has not affected the customer experience, any of the customer journeys, or customer billing in any way. The smart meters currently installed by British Gas hold the half hourly data in an internal memory bank for a period of 13 months. As half hourly data will not have been collected for differing periods, for certain customers, British Gas is investigating a technical solution to recover this data.
	Qualitative Feedback on Equipment from Participant Interviews: Interviews with a sample of the intervention group (15 participants) found that usage of the devices provided varied: • The smart energy display was the most widely used device with 13 out of 15 using this regularly, to monitor energy use and, where relevant, credit. Seven said they had changed their behaviour as a result. However, seven reported technical problems with their display. • 11 of the 15 were using their LEDs lightbulbs. Usage would have been increased if the CFOs had been able to fit the bulbs for customers (though partners felt that safety issues may make this impossible). • The kettle being used by eight out of 15. Reasons cited for not using it included that it was too heavy, not needed, had insufficient capacity, had stopped working or was difficult to use. Demonstrations of the equipment by the CFOs would have slightly increased usage. • The standby shutdown is being used by seven out of 15 interviewees; others suggested they didn't need it or weren't sure how it worked. Usage of this device would have been increased if CFOs could have set up the equipment for some participants. • Six of the 15 said they had read the advice leaflet, only one of whom said they had implemented any of the advice.

9.8 Learning Outcomes: Research Aspect

No.	Lesson Learnt
L8.1	**Research Trials Targeting Fuel Poor Customers:** The primary observation from the recruiting phase of the trial is that fuel poor customers seem as willing to participate in research projects as non-fuel poor customers. A direct comparison however is difficult because, to the project's knowledge, no other UK trial has so clearly defined its research population, participant selection criteria, and sample frame, and recorded nonresponse rates accurately enough to define the response rate of the trial in a comparable manner to **energy**wise.
L8.2	**Response Rates:** All of the trials of smart metering and related DSR technologies of which the project is aware have recruited on an opt-in basis with an unbounded sample frame achieving low participation rates. The **energy**wise project achieved a 40% response rate which far exceeded all industry and academic expectations. This shows that the application of best practice social research and project management methods for the recruitment of participants can achieve higher response rates in energy trials from any subsection of the population.
L8.3	**Drop Out Rates:** Drop outs were higher than anticipated – see L4.1.
L8.4	**Trial 1 Start Dates:** Originally the project partners envisaged to use the installation date as individual Trial 1 start date for each participant. However, given the differences between British Gas and PassivSystems installation dates and the delivery dates of the energy efficiency devices and energy efficiency advice leaflet, it was agreed that is was more appropriate to use the date of the first smart meter readings coming through as the start date for each individual household. This is because, from the participant's perspective, the receipt of the smart energy display and the interaction with the British Gas Smart Energy Expert constitutes what is likely to be the single largest intervention in energy savings terms. Local levels of trust are higher for households who have Bengali as their primary language.
L8.5	**Research Insights:** Even if it is too early to draw substantial conclusions from the quantitative analysis of energy data, conclusions drawn from analysis of the two surveys (the HES, and the ESC survey) presented elsewhere in this report provide substantial and valuable early learnings from the project.
L8.6	**Survey Administration:** The approach of CFOs assisting customers with the completion of the HES during installation visits resulted in a good response rate to the survey, of 95%. 5% were left with participants for self-completion and they were all returned bar one.
L8.7	**Energy Social Capital Survey Insights:** The findings from the survey indicates some level of information seeking about energy and a fair amount of 'energy social capital': • 146 out of the 179 respondents knew people in their social networks to whom they would turn for energy related advice; • 80 respondents (45%) had had a conversation in the last six months related to electricity; and • Trust varied through the sampled population, with a majority trusting people in the local area, while only 21% trusting people 'in general'. The findings suggest that electricity usage and energy related issues are not a specific or overwhelming concern for this group, but most have social resources they can turn to if there is an issue they'd like to discuss and many use the media or other organisations as sources of information and advice.

L8.8	**Qualitative Customer Insights:** Learning to-date includes: • Some participants don't use their central heating, for various reasons; including perceived cost and perceived health impacts. Some use additional heating at certain times, e.g. when they want to get warm instantly when getting home from work; • Several participants reported problems with their central heating and most of these use alternative electric heating to compensate for this; • Appliances move around with extended family members – e.g. visiting grandchildren bring electronic games consoles with them. Similarly, visiting family members may help with e.g. washing, which impacts on the timing of appliance use; • Generally, feedback on the surveys showed that the vast majority found them easy to fill in, with only one (out of 52) finding it time consuming and three raising concerns about confidentiality or sensitivity of data; and • Two people mentioned that having a Bengali speaking CFO was a help.
L8.9	**Network Insights:** The main outcome of the analysis of the network data is that the load profiles of the trial participants align well with the load profiles of the secondary substations to which they are connected. This has potentially beneficial implications for any realised energy savings or peak demand shifting by the trial participants, since these load reductions and/or shifts are more likely to align with the reinforcement deferral requirements of the secondary substations.

10. Conclusion

This report is focused on the results from the first six months of Trial 1 and on the valuable customer insights collected through the research surveys, 30 interviews with trial participants and several interactions between the customers and the CFO team. This last chapter summarises the key lessons learnt generated from the project through the set-up phase of Trial 1 (including the selection and recruitment of trial participants, and the provision of energy saving interventions through the installation phase for Trial 1), the surveys administered to the trial participants and the operational phase of the energy saving trial (including the data analysis and the customer protection measures in place).

Including the MDU recruitment undertaken in 2016, the project approached overall 1,352 households in Tower Hamlets with a total of 538 sign-ups, which represented a response rate of 40% and exceeded the 33% target. The project subsequently experienced 209 drop-outs, resulting in 329 active participants as of 14 June 2016. Out of these 329 households, 42% of the properties are in EPC rating band C, 41% in band D and 16% in band E, while only two properties are in band F and one in band G. This may be an indication of improvement works carried out by the social housing providers before October 2013 (the threshold set up by the project for the exclusion criteria of trial participants).

Other interesting findings around the households involved in the project, their demographic and their attitude towards sources of information around energy have been gathered through the HES and the ESC survey developed by University College London. Looking at the 278 participants who completed the survey, it is evident that the majority of trial participants are Bangladeshi (154 households out of 278) or White British (58 out of 278), which is reflected by the primary language spoken at home (114 households speaking Bengali, 119 English, and 25 English and Bengali). Also, the **energy**wise participants appear to have significantly larger households compared to the general population (3.53 members in average versus 2.38) with intervention group showing a higher occupancy level than the control group. While the household's income is generally quite low, several households reported that they receive housing benefits and child benefits, followed by some receiving income support and/or other state benefits. Finally, 76 households out of 278 have at least one child under five years old while 57 households have elderly residents (aged over 65).

The responses received to the ESC survey indicate some level of information seeking about energy and a fair amount of energy social capital with the majority of energy social capital resources lying within the family. The findings suggest that electricity usage and energy related issues are not a specific or overwhelming concern for this group, but most have social resources they can turn to if there is an issue they'd like to discuss and many use the media or other organisations as sources of information and advice.

Interactions between customers and CFOs were also identified as another channel to gather information around attitudes towards energy. For example, it was captured that some participants don't use their central heating, while several reported problems with their central heating (with most of these using alternative electric heating to compensate). It was also found that extended family members move between households, which may alter not only the pattern of electricity consumption, but also the appliances in the home.

All active participants have received their monitoring equipment and Trial 1 interventions (where relevant) depending on their group allocation. Through the completion of Trial 1 installations and the provision of other energy efficiency measures such as energy efficiency devices and advice, the project has gathered valuable learning on how to deliver energy saving interventions to this customer base and particularly how to address some of the challenges faced by the smart metering roll-out when extended to flats and tall buildings with difficult meter arrangements. As many fuel poor customers live in flat or tower blocks, overcoming these challenges is key to enable them accessing the benefits of smart metering solutions. Within this context, the project has successfully demonstrated the UK's first end to end installation of residential smart meter sets operating across a multi dwelling unit/tall and difficult building solution.

Regarding the assessment of customer benefits in energy saving campaigns with fuel poor customers, analysis of electricity consumption (via smart meter data) is the primary channel for investigating any energy saving resulting from the interventions provided to the intervention group. Electricity consumption in the intervention group is compared to consumption in the control group (who did not receive the intervention measures). The analysis of the six month worth data included in this report focused on the data received from August 2015 to January 2016 in order to maximise the number of households transferring meter readings available. Only daily readings from credit customers were included in the six month view given the data received by University College London as of 31 January 2016, which resulted in a total of 29,657 daily smart meter records from 211 participants.

The analysis of the electricity consumption based on six month data presented here has found no statistically significant evidence of energy saving in Trial 1. A difference in household size and previous year annual energy consumption has been observed between the intervention and control group. However, preliminary analysis has also shown that correcting for the household occupancy level of each household and their estimated annual consumption from the year prior to the trial did not yield a statistically significant saving between the intervention and control groups with the data currently available. As such, further analysis of the impact of these factors and the re-assessment of Trial 1 energy savings including the half hourly data analysis will be published in the update report in December 2016 when the full set of Trial 1 data is available. With more data available and refined analytical methods, it is entirely possible that the project will find evidence of energy saving realised through the provision of smart metering solutions and energy efficiency measures.

The update report will also include an update of the assessment of the network impacts associated with any energy savings identified with 12 months of data. However, several activities have been undertaken in the first six months of Trial 1 regarding the network modelling within the trial area. First of all, the load forecasting scenario tool used by UK Power Networks to model future loads across its three licence areas, the EELG model, was modified for the purpose of the **energy**wise project in order to address fuel poor household archetypes in the domestic sector. At the completion of the trial, this will allow the integration of scenarios of how the fuel poor customers respond to energy saving and demand shifting interventions into its network planning processes.

Through the analysis of the half-hourly monitoring data of all available credit meter customers in the control group early learning has been generated in relation to the electricity usage characteristics of fuel poor customers (as represented by the participants in this trial) and how the participant load profiles relate to those of the network assets to which they are connected. From a preliminary analysis, it can be seen that the average consumption of the **energy**wise trial participants is considerably lower than that observed in other projects, such as the LCL and CLNR trials, over the same calendar months. This is in line with the findings of the LCL trial analysis of the impacts of household income on average diurnal consumption profile and reflects the demographic composition of the participants in the **energy**wise study, which is targeted at fuel poor customers.

Results also show that there is a strong correlation between the **energy**wise participant profiles with the mean secondary substation load profiles indicating that energy saving and peak shifting responses from the trial participants have the potential to directly benefit the secondary substations to which they are connected. Less correlation has been observed in the case of primary substations, which reflects the more diversified nature of the primary substation loads and the higher proportion of industrial and commercial loads (which typically increase loading during the daytime) at this level.

Finally, the project also had looked at different customer protection measures put in place to ensure no harm is caused to participants because of the trials. Among these, it was proved challenging to develop a temperature monitoring protocol for taking action related to evidence of dangerously low temperatures in individual homes. Partners were in agreement that to accurately assess the risk to a household, a household visit would be necessary, but this was deemed too intrusive. A risk assessment system has been devised that uses all the information held by project partners, which is felt to offer the best approach, though is recognised as having limitations. No evidence of a trial effect on the temperature in the household was identified through the data analysis carried out by University College London over the winter months, with both groups experiencing the seasonal impact of lower external temperature in a similar manner.

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Appendix A: Detailed data quality processes

The tables below show the data quality checks being carried out before analysing the data in detail, and which may be useful to colleagues and researchers running other trials.

QA Process	Check to ensure data matches file specifications
Description	Various basic checks to ensure data matches file specifications e.g. • Measurement Description = “Electricity” • Units = “Kwh”
Result	No issues identified

QA Process	Check for duplicate records
Description	Check for duplicate records in smart meter data. **Method:** Use SQL “Group By, Having Count > 1” functions e.g. “GROUP BY MPAN, date_time_of_capture_effective HAVING (((Count(parameter_1))>1))”
Result	No duplicate records identified

QA Process	Check for missing records
Description	Check that data has been received for all active participants who are expected to have smart meter data. **Method:** Count participants with smart meter data compared to participants eligible for inclusion in this report analyses.
Result	Records for seven participants currently identified as missing. The data for these participants may be available for subsequent reports/analyses as data quality processes amongst the various project partners are refined.

Missing Records			
Group	Eligible participants for this report (Credit)	Eligible participants for this report with Daily Meter data	Fulfilment %
Control	107	102	95%
Intervention	112	110	98%

QA Process	Check for missing data
Description	Check that all data has been received for all active participants who are generating smart meter data (Daily Reads). **Method:** Count possible smart meter reads (daily) compared to smart meter reads (daily) received.
Result	Missing data in the Smart Meter (Daily Reads) dataset has been identified.

Missing Data	Eligible participants for this report with smart meter data		
Group	Daily Reads	Possible Reads	Fulfilment %
Control	15,275	16,506	93%
Intervention	17,723	19,660	90%

QA Process	Check for distribution of missing data
Description	Check the distribution of missing data. This check is necessary to investigate whether data is: Missing in a random way Skewed across intervention and control groups. **Method:** Analyse smart meter reads by group and date.
Result	• Data is not missing in a random way and some system issues appear to have contributed to missing data (e.g. most meters do not have data for 1 and 2 December 2015). • However, there is little evidence of a skew in the missing data across the control and intervention groups with missing data showing a broadly similar distribution pattern.

QA Process	Check for potentially erroneous data
Description	Smart Meter Daily Reads • Check for negative values • Check for zero values
Result	• No negative values identified • 59 zero values identified. These have been included in this report but may be excluded from subsequent reports after further data quality analyses.

QA Process	Check for potentially faulty meters
Description	Check for meters that have constantly reported the same value. Method: Min(parameter1) = Max(parameter1)
Result	One meter identified as likely to be faulty. The records associated with this meter have been excluded from this report.

QA Process	Check for dubious/suspect data
Description	Smart Meter Daily Reads • Check for values < 1 kWh • Check for values > 25 kWh
Result	"Suspect" values identified: • Values > 0 AND < 1 kWh = 46. Lowest value = 0.002 kWh. • Values > 25 kWh = 219. Highest value = 51 kWh. These records have been included in this report but may be excluded from subsequent reports after further data quality analyses.

QA Process	Compare Daily v Half-Hourly smart meter data
Description	For participants that have both Daily and Half-Hourly data, check that the Daily Kwh derived from both datasets is the same. • Use Effective Date/Time to ensure the same 24 hour period is used for both datasets. • Use Daily Valid_24H flag and HH Count = 48 to ensure exactly 24 hour data coverage in both datasets.
Result	No issues identified. Where we have matching records exactly 24 hour coverage, daily kwh is the same.

QA Process	Create new variable (Daily Reads): date_time_of_capture_effective
Description	A date_time_of_capture of "23/01/2016 00:00:00" is really recording the electricity used the previous day i.e. "22/01/2016 00:00:00" to "22/01/2016 23:59:59". To correct this issue, one second is subtracted from date_time_of_capture using the function "DateAdd("s",-1,[date_time_of_capture])" so that the date_time_of_capture_effective will be recorded at 23:59:59 on the day that the energy is used for normal meter readings.

QA Process	Create new variable (Daily Reads): prev_date_time_of_capture_effective
Description	A date_time_of_capture_effective for previous reading created using the LAG function: LAG(date_time_of_capture_effective) ORDER BY mpan, date_time_of_capture_effective

QA Process	Create new variable (Daily Reads): prev_read
Description	Previous reading created using the the LAG function: LAG(parameter_1) ORDER BY mpan, date_time_of_capture_effective

QA Process	Create new variable (Daily Reads): daily_kwh
Description	Daily kwh calculated using the function: Parameter_1 - prev_read

QA Process	Create new variable (Daily Reads): hours_to_prev_read
Description	Hours between current and previous read created using the function: DateDiff("h",[prev_date_time_of_capture_effective],[date_time_of_capture_effective])

QA Process	Create new variable (Daily Reads): valid_24h_read
Description	Flag to denote a "valid" read taken at 23:59:59 with exactly 24 hours to the previous read created using the function: IIf([time_of_capture_effective]=TimeValue("23:59:59") And [hours_to_prev_read]=24,"Y","N")

QA Process	Create new variable (Daily Reads): meter_fault_1
Description	Y" if meter appears to be faulty when Min and Max reading are equal i.e. meter has only ever reported the same reading.

Appendix B: External Control Group

A key objective of the **energy**wise project is to determine the extent to which the findings observed in the Tower Hamlets area can be generalised to the wider fuel poor and vulnerable population in social housing nationally. The external control group can play a key role in this and particularly it plays three key research functions within the **energy**wise research design:

1. Firstly, it allows us to determine whether external shocks, such as price rises, are the real reason behind any observed change in energy consumption either in terms of energy savings or energy shifting. In Trial 2 there will not be an internal control group, thus if a price rise occurs partway through Trial 2 then the project needs the external control group to determine whether any observed changes in consumption in the intervention group arise from the intervention or from such external factors.
2. Secondly, the external control group allows the project to determine whether there has been any contamination of the internal control group within Trial 1 arising from their close proximity to the intervention group.
3. A third role for the external control group is to determine the extent to which the energy savings or energy shifting observed in the trial participants are likely also to occur if the project is replicated in other areas nationally.

In order to determine this, University College London is constructing an external control group that matches the participants recruited into the trial in terms of their fuel poverty, vulnerability, and social housing characteristics as closely as possible.

The approach for constructing the external control group has been revised in light of the geographic remit of the LCNF (Great Britain rather than England) and the absence of comparable sub-regional statistics for Scotland and Wales. In addition, it was realised that data collected in the HES completed by participants once they had joined the trial would provide a substantially better basis for drawing a statistically comparable external control group from the British Gas smart meter customer pool. After consultation with British Gas it was identified that they hold historic half-hourly data for all smart-meter customers and (once consent is given) this historic data can be used for external control group purposes.

Thus the external control group can be constructed after the initial recruitment period, as the external control group data can be collected for the desired time period even though Trial 1 has already started. In light of the significant scientific benefit gained it was decided to defer construction of the external control group until after the HES data was collected, entered, cleaned and analysed.

With respect to the design of the external control group the following has been agreed. Samples of ~680 will be drawn from each of the 14 DNO regions (including London) in a manner replicative of how the **energy**wise participants were sampled. This comes to a total sample size of ~9520. The sample is drawn through a two stage process – first geographic sampling based on areas of high fuel poverty in GB, second screening these for income and age of property as a proxy of property energy efficiency.

<u>General approach</u>

In non-statistical language the general approach to constructing the external control group is a follows. In order to allow generalisation to each DNO region, from each DNO region (to the extent to which there are suitable customers in the British Gas smart meter database) a sample of customers that replicate those in the **energy**wise trial in that region will be drawn. This customers' sample varies from region to region, so this approach provides a way of statistically characterising the customers similar to those in the trail in each DNO region, and understand their load profiles and how they respond to external shocks (such as price rises). As the CLNR control group insights report notes: "While electricity use was found to be linked to demographic indicators, other variables such as ambient temperature and time of the year have a much greater impact on electricity use, in particular when predicting the peak demand on any particular day". This means that findings for each DNO region need to be adjusted to account for this. This then generates 14 sub-samples within the external control group to compare the **energy**wise results to. This will support translating findings into each DNO region and, when added together, will provide an appropriate level of statistical power at the national scale for external shocks in Trial 2.

For the final analysis of Trial 1 the internal control group will then be compared to each of these external control sub-groups. For events that happen at the national scale (e.g. a Brexit vote in the referendum or a global shift in in gas or electricity prices) it would be expected that all these control groups move in unison – but each from their different baseline. It is known that electricity is consumed differently in each DNO region from Office of National Statistics data, so while any external shock will move them at the same time and in the same direction, the magnitude of the change will vary around the country depending on the regional baseline.

In terms of sizing the external control group, the primary consideration is how well the internal control group tracks these external control sub-groups in each DNO region. The monthly mean electricity consumption by the fuel poor in each region will follow a slightly different trajectory over the year (there are a host of seasonal and regional influences on electricity use and much stronger ones for gas use that will translate into economic pressure on electricity bills). Because of this, the trajectory of the internal control group won't either match (it will be shifted by the different baseline consumption), or track exactly parallel over time, to the trajectory in the external group in each region. Confidence in generalising from findings in the trial area, to the fuel poor in other DNO regions, depends on the statistical power with which differences in the trajectories between the internal control group and each DNO's external control sub-group can be detected. This will also determine the extent to which internal control group contamination effects can be detected, as it is the comparison of the trajectory of the internal control group, vis-a-vis the external control groups and the intervention group that will show if the internal control group is being contaminated by leakage from the intervention group. In order to determine if any internal control group to intervention group variance is due to contamination effects, it is first necessary to quantify the natural variation in trajectory between groups that may be expected. In the **energy**wise project this will be assessed by looking at DNO sub-group to sub-group regional variation. If internal control group to intervention group variance exceeds this, this would be an indicator of contamination effects. If all the other DNOs' external control sub-groups trend up, and the internal control group trends down parallel with the intervention group, then contamination effects would be suspected. If the trajectory is within the bounds of variability of others then contamination effects are unlikely.

In terms of generalising to each DNO region, if the internal control group tracks down slightly over time, and a DNO region tracks up slightly, it is important to know if this difference is statistically significant at the levels defined for the project, and if so make this adjustment when results are generalised from Tower Hamlets into that DNO region. The capacity to resolve such differences between the internal control group's tracking, and each DNO's external control group's tracking, is a function of the sample size in each DNO region.

In order to calculate the size needed in each DNO region, a figure for the statistical power with which we want to be able to generalise to each region is needed. For the sake of consistency with other parts of the trial this has been agreed to be 75%.

Using the mean and standard deviation values taken from the previous year's Estimated Annual Consumption values for trial participants (which are close to those in the nearest corresponding CLNR sub-group), a trajectory difference of 100 kWh between the internal and external control groups of the course of Trial 1 with 75% statistical power could be resolved with a sample size of 680 in each of the 14 regions. This would make the total sample size 9520 stated above. This figure of 680 in each region exceeds the requirement in the bid document of calculating external validity using 5% margin of error and a 90% level of confidence (680 provides a 3.1% margin of error at the 90% level of confidence) so the minimum size of the external control groups in each DNO region is determined by the need to estimate contamination effects and to be able to tell DNOs replicating the approach that they can know their expected energy savings to within 100 kWh with 75% statistical power.

Appendix C: SDRC 9.3 Evidence and Sections

Criterion (9.3): Energy Saving (Impact of energy saving trial interventions – level of fuel poor participation and network impacts)	
Evidence Item	**Relevant Section of the report**
Quantitative analysis of Trial 1 energy savings through within-trial intervention-group to control-group comparison.	• Section 5 of the report provides a six month view of the quantitative data analysis of Trial 1 energy savings through the comparison of the within-trial intervention group to control group. The analysis is based on the data available at the end of the six month period starting from 1 August 2015 to 31 January 2016 and it is therefore focused on daily meter reads from credit customers. • Key lessons learnt are also summarised in Section 9.
Quantitative analysis of Trial 1 control-group contamination effects through within-trial control-group to external to trial control-group comparison.	• Section 5 of the report outlines the analysis of the contamination effects between within-trial intervention and control group. This focused on the identification of evidence of any potential selection bias or differential attrition between the two groups, which are the two main effects that may have had an impact in the first months of trial 1. • Appendix B also provides an overview of selection strategy of the external control group that will be used at the end of trial 1 to identify any contamination occurred on course of the trial. • Key lessons learnt are also summarised in Section 9.
Statistical generalisation of the energy savings to the wider UK Power Networks, British Gas and national fuel poor customer base.	• Similarly to the previous category, Section 5 of the report outlines the strategy to assess the statistical generalisation of the findings from trial 1. A ~93% confidence in generalising the potential savings achieved by intervention group to the wider population was estimated.
Representation of network impacts through half-hourly network modelling within the trial area.	• Section 6 of the report presents the half-hourly network modelling undertaken within the trial area with the six month worth of data available from Trial 1. Under the scope of the project the Element Energy Load Growth Model was specifically 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 **energy**wise participants profile to identify the impact of potential energy savings on the network. • Key lessons learnt are also summarised in Section 9.
Comparison of realised energy savings against previous estimates of technical potential energy savings in the fuel poor customer group.	• Section 7 of the report estimates the technical savings potentials for each of the trial 1 intervention devices to obtain a sense of the scale of energy savings that could be realised in trial 1. The identified theoretical potential savings will be compared with any realised energy savings observed at the end of trial 1.
Insights on customer protection during the trial.	• Section 8 of the report outlines the outcomes of the customer protection activities in place to ensure the project has no harm to the trial participants. These include a regular review of the vulnerability status of trial participants, procedures to capture and escalate customer issues, customer panels and the temperature monitoring protocol. The project also monitored the compliance to project's Communication Plan and Data Privacy Strategy. • Key lessons learnt are also summarised in Section 9.